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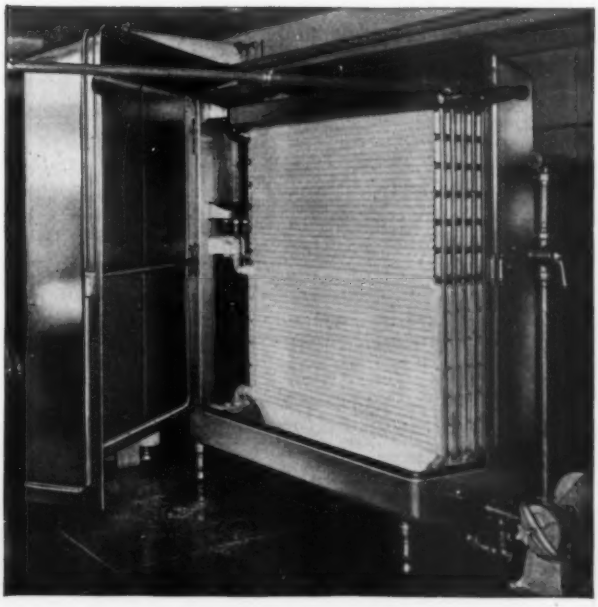

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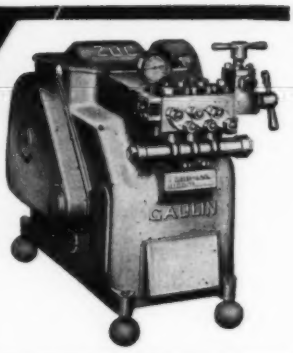

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JOURNAL OF DAIRY SCIENCE

VOLUME XXI SEPTEMBER, 1938 NUMBER 9

A STUDY OF THE RELATION OF THE FEED CONSUMED BY THE COW TO THE COMPOSITION OF MILK FAT AND THE PROPERTIES OF BUTTER*†

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The fact that cows can produce butterfat from rations low in ether extract has been shown by Jordan and Jenter (1), Hills (2), Lindsey (3) and Buschmann (4). Hansson and Olofsson (5) and Magi (6) have reported hard butter following winter feeding with hay and grain. Hansen and Stensberg (7) classified oats with the feeds producing normal butter and barley in the group producing hard butter. Many workers present data concerning the influence of feed consumed by the cow on the composition of butterfat. Few studies have been conducted to determine the relationships between observed changes in butterfat composition and its hardness due to feeding practice.

EXPERIMENTAL METHODS

Seven-day feeding periods were used except for part of the oil feeding trials in which six days were used. Although samples were taken at the end of each period, the roughage feeding was extended through two or more periods in order to allow time for the animals to reach equilibrium. Cows producing more than one pound of butterfat daily were used as experimental subjects. A basal mixture consisting of 70 parts barley and 30 parts bran, by weight, was used as concentrate unless substitutions or additions were made, as during the oats, corn, or oil feeding trials. Samples of butter and butter oil were prepared at the end of each feeding period as described by Coulter and Hill (8). Saponification value, iodine absorption value, Reichert-Meissl numbers, and melting points were made for butterfat samples. Hardness of butter and butterfat was determined according to the method described by Coulter and Hill (8). Butter hardness was not

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determined for all samples since the correlation coefficient between hardness of butter and butterfat for 28 samples was + 0.905.

The effect of changing from the herd ration to the experimental rations consisting of barley, bran and hay (timothy or alfalfa)

Two groups of two cows each, consisting of one Jersey and one Holstein, were used in this experiment. The herd ration included a balanced grain ration, alfalfa hay and corn silage. Commercial casein was added to the timothy hay ration in sufficient quantities to properly balance the ration. A like amount of casein was fed to the group receiving alfalfa to equalize any effect the casein might exert. The experimental rations provided .23 pounds less fat daily per cow than the herd ration. As shown in Table 1,

TABLE 1

The effect of changing from the herd ration to the experimental rations on the fat constants and the hardness of butterfat

Period		Hay	Chemical constants			Physical constants	
			Saponification value	Iodine value per cent	Reichert-Meissl number	Melting point °C.	Hardness grams
Group I	1	Herd[1]	236.1	29.34	30.32	32.55	1342
	2	Timothy	231.8	31.71	27.11	32.90	1307
	3	Timothy	231.4	31.43	26.52	33.15	1439
	4	Timothy	234.6	28.15	29.48	32.90	1532
	5	Timothy	235.2	25.48	28.84	33.90	1992
	6	Timothy	236.4	25.01	30.04	34.00	2044
	7	Timothy	235.9	25.05	29.37	34.25	2172
Difference Period 1 to 7 (19 days)			− 0.2	− 4.29	− .95	+ 1.70	+ 830
Group II	1	Herd[1]	233.5	32.40	27.94	32.05	1205
	2	Alfalfa	233.8	29.40	28.43	33.45	1869
	3	Alfalfa	234.0	28.79	28.64	33.10	1424
	4	Alfalfa	232.2	30.00	26.47	34.20	1610
	5	Alfalfa	233.1	26.20	25.57	34.85	2321
	6	Alfalfa	232.7	27.32	26.90	34.82	2216
	7	Alfalfa	234.1	27.70	26.87	34.00	1872
Difference Period 1 to 7			+ 0.6	− 4.70	− 1.07	+ 1.95	+ 667

[1] Fed on the regular herd grain ration, alfalfa hay, corn silage.

there was considerable change in chemical and physical constants in the butterfat from both groups of cows. In Group I there was a drop in iodine value of 4.29, in Reichert-Meissl number of 0.95, while melting point and hardness increased 1.70 degrees C. and 830 grams respectively. In Group II there was a decrease of 4.70 in iodine value, of 1.07 in Reichert-

Meissl number, and an increase of 1.95 degrees C. in melting point and 667 grams in hardness. Changes in saponification value were practically negligible. All the butters for period 5, 6, and 7 were scored "hard and brittle."

Influence of alfalfa hay, timothy hay, or combinations of these hays with beet pulp

Results for groups I and II, shown in Table 2, are a continuation of Table 1, except that they are averages for three periods. The groups were reversed in order to determine the response of each group to each roughage. Variances in the data are not sufficient to ascribe a specific effect to any one of the combinations fed. All butters during these periods were pronounced hard and dry by the judges.

Influence of heavy alfalfa feeding

In a further attempt to establish the effect of alfalfa on the chemical constants and hardness of butterfat, very high levels of alfalfa were fed to cow 419, a Holstein. This cow consumed 85 per cent of her total digestible nutrients in the form of alfalfa hay. Table 2 demonstrates a considerable

TABLE 2

The effect of feeding timothy hay, alfalfa hay, and beet pulp on the chemical and physical constants of butterfat (averages)

	Roughage	Chemical constants			Physical constants	
		Saponification value	Iodine value per cent	Reichert-Meissl number	Melting point °C.	Hardness grams
Group I	Timothy hay	236.2	25.03	29.71	34.12	2108
	Alfalfa hay	234.2	26.30	28.41	34.30	2178
	Alfalfa hay and beet pulp	233.5	27.21	27.61	33.64	1943
Group II	Alfalfa hay	233.4	27.51	26.88	34.41	2044
	Timothy hay	233.6	27.93	26.71	34.02	1813
	Timothy hay and beet pulp	234.1	28.35	25.96	34.12	1829
Cow 419	Normal alfalfa	232.9	31.49	29.65	.....	1253
	Heavy alfalfa[1]	230.8	35.85	28.01	.....	1001
	Normal[2]	229.6	34.10	28.55	.....	1231

[1] Average three periods.

[2] First period following heavy alfalfa.

change in butterfat constants during the heavy alfalfa feeding periods. The iodine value increased 4.36, the Reichert-Meissl number declined 1.64, with a decrease of hardness of the butterfat of 252 grams. The body of the butter was normal in all cases, although it was somewhat harder for the

basal periods. It is evident from Table 2 that the alfalfa hay in this experiment was responsible for increasing the iodine value and decreasing the hardness of butterfat more than the alfalfa-barley-bran ration. When the alfalfa was reduced to normal amounts in the after period the hardness of the fat increased without a corresponding decrease in the iodine value. Richardson and Abbott (9) show similar increases in iodine value during alfalfa feeding, but in spite of these changes, report a "sticky" crumbly butter unless special churning procedure is followed.

The effect of including oats and corn in the ration on the chemical constants and physical properties of butter and butterfat

The preceding data, representing the roughage feeding experiments, showed that a hard butter of low iodine value was produced except when alfalfa was fed. The following experiments were planned in an attempt to ascertain the influence of substituting cereals higher in fat for the barley part of the ration. In all cases basal ration refers to the mixture, 70 parts barley and 30 parts bran, fed with alfalfa hay. Oats or corn replaced the barley in the basal ration during these experiments. In each case the cereal supplied 40–50 per cent of the total digestible nutrients. The experiment for cow 419 had to be altered somewhat because the oats were of such low grade, containing but 2.51 per cent ether extract compared to 3.73 per cent for the lot fed to the groups. Corn was fed with the oats to avoid

TABLE 3

The effect of substituting oats or corn for barley on the chemical constants and hardness of butterfat (average)

	Ration	Chemical constants			Physical constants	
		Saponification value	Iodine value per cent	Reichert-Meissl number	Melting point °C.	Hardness grams
Group I	Basal[1]	231.7	28.31	27.47	34.63	1884
	Oats	228.7	35.51	28.81	33.12	1140
	Difference	−3.0	+7.20	+1.34	−1.51	−744
	Corn	229.4	35.15	27.74	32.70	1120
	Difference	−2.3	+6.84	−0.27	−1.93	−764
Group II	Basal[1]	231.9	30.06	25.80	33.75	1757
	Oats	228.4	34.56	25.47	32.97	1372
	Difference	−3.5	+4.50	−0.33	−0.78	−385
	Corn	227.4	35.95	23.79	32.15	1093
	Difference	−4.5	+5.89	−2.01	−1.60	−664
Cow 419	Basal[1]	233.1	34.35	29.84	.....	996
	Oats and corn	230.5	36.37	29.30	.....	926
	Difference	−2.6	+2.02	−0.54	.....	−70

[1] Barley, bran and alfalfa hay.

underfeeding as well as to increase the fat content of the ration. The data presented in Table 3 show that during the oat feeding period in Group I the saponification value, melting point, and hardness decreased 3.0, 1.51° C. and 744 grams respectively. The iodine value increased 7.20 and the Reichert-Meissl number 1.34. Corn brought about very similar changes except for the Reichert-Meissl which decreased slightly. Group II gave results in the same direction, but in less degree except for the Reichert-Meissl which decreased, especially during the corn feeding. Results for cow 419 show an increase of only 2.02 for the iodine value with no appreciable change in hardness. The butters produced during these periods were graded normal in body, as contrasted to the harder butters produced during the basal periods.

The effect of feeding fats and oils on the chemical constants and physical properties of butter and butterfat

The literature reveals a close relationship between the quantity of fat in the ration and the influence on the properties of butterfat. It was evident in the experiments reported in Table 4 that the oil in the corn and oats was responsible for the effects observed. Further study of feeding fats and oils possessing widely different characteristics was undertaken. The oils and fats studied were corn oil, linseed oil, cottonseed oil, tallow, butterfat and coconut oil. The iodine values of the several fats were as

TABLE 4

The effect of feeding corn oil on the chemical and physical constants of butterfat

Group	Ration	Amount oil fed lbs.	Chemical constants			Physical constants	
			Saponification value	Iodine value per cent	Reichert-Meissl number	Melting point °C.	Hardness grams
II	Barley, alfalfa, bran	0.0	228.7	33.19	24.40	.....	1382
		0.3	226.4	37.43	25.12	.....	1118
		Difference	−2.3	+4.24	+0.72	.....	−264
III	Herd ration with corn silage and alfalfa	0.0	236.0	30.50	31.15	32.10	1347
		1.0	228.3	41.00	30.36	32.25	976
		Difference	−7.7	+10.50	−0.79	+0.15	−371
IV	Same as Group III	0.0	234.2	30.28	30.60	32.55	1551
		1.0	229.0	40.20	31.93	32.60	1127
		Difference	−5.2	+9.92	+1.33	+0.05	−424
Cow 151	Barley, bran, alfalfa	0.0	232.1	32.50	29.00	.....	1396
		0.8	231.3	35.78	29.00	.....	1115
		Difference	−0.8	+3.28	0.00	.....	−281

follows: for coconut oil, 7.94; tallow, 37.48; cottonseed oil, 108.55; corn oil, 123.14; and linseed oil, 169.04. The feeding conditions were standardized so that the effect of feeding the oil could be compared with a preliminary and an after period in which no extra oil or fat was fed.

During these oil feeding periods, Groups I and II, and cows 151, a Jersey, and 419 were fed the basal grain ration and alfalfa hay. Groups III and IV, composed of three cows each, a Guernsey, a Holstein, and a Jersey, received regular Experiment Station herd ration, with corn silage and alfalfa hay, according to milk production and body weight. Groups V and VI, composed of two cows each, a Guernsey and a Jersey, were fed the Experiment Station ration and alfalfa hay according to weight and milk production. These diverse feeding practices offered an opportunity to study the effect of fat feeding under varied conditions. The fat or oil was added to the regular ration, thereby increasing the total digestible nutrients.

a. *Influence of feeding a low level of corn oil*—This experiment was designated to determine if corn oil when fed in addition to the basal ration would produce results similar to those secured when corn was fed. The digestible fat in the corn ration exceeded that in the basal ration by 0.28 pounds daily for the Jersey cows, and 0.31 pounds for the Holsteins. These amounts of oil were added to the basal ration of Group II. Table 4 shows the results secured. The iodine value and Reichert-Meissl number increased 4.24 and 0.72 respectively, whereas, the saponification value decreased 2.3 and the hardness declined 264 grams. Except for the Reichert-Meissl these alterations from the basal periods are in the same direction as those shown in Table 3 for oats and corn feeding. The higher iodine value obtained on the basal ration in Table 4, as compared with Table 3, may be attributed to advance in lactation. The body of the butters was normal in all cases.

b. *Influence of feeding corn oil at higher levels*—Table 4 also shows results following the feeding of one pound of corn oil to Group III and IV and 0.8 pound of corn oil to cow 151. The saponification value declined 0.8 for cow 151 and 7.7 for Group III. The iodine value increased 3.28 for cow 151 and 10.50 for Group III. Changes in Reichert-Meissl number were not consistent and in melting point were insignificant. An unmistakable decrease in hardness of the fat resulted, this decrease being 281 grams for cow 151, 424 grams for Group IV, and 371 grams for Group III.

Thiocyanogen values were run on the butterfat from cow 151 in the basal and corn oil feeding periods using the method of Kaufman (10) as modified by Zeleny and Bailey (11). Using the difference between the iodine value and the thiocyanogen value as a measure of fatty acids less saturated than oleic it was found that the difference for the corn oil feeding period was only 0.38 greater than for the mean difference of the two basal periods, being 3.02 for the latter and 3.40 for the former.

c. *Influence of feeding linseed oil*—Linseed oil was fed in quantities from 0.8 to 1.25 pounds daily. Table 5 gives the results. Group V showed the greatest changes in iodine value, but the decrease in hardness was

TABLE 5

The effect of feeding linseed oil and cottonseed oil on the chemical constants and hardness of butterfat

Group	Amount of oil fed lbs.	Chemical constants			Hardness, grams
		Saponification value	Iodine value, per cent	Reichert-Meissl number	
	Linseed oil				
Cow 419	0.0	231.9	34.00	28.81	1138
	0.9	227.2	42.21	27.63	922
Difference		−4.7	+8.21	−0.18	−216
Cow 151	0.0	233.7	29.29	29.20	1885
	0.8	229.7	41.17	30.11	1047
Difference		−4.0	+11.88	+0.91	−838
V	0.0	227.7	38.17	26.33	1126
	1.25	219.1	54.28	24.34	771
Difference		−8.6	+16.11	−1.99	−355
VI	0.0	226.8	42.45	25.73	725
	1.25	218.6	50.85	22.87	685
Difference		−8.2	+8.40	−2.92	−40
	Cottonseed oil				
III	0.0	236.0	30.47	32.45	1502
	1.0	228.9	38.35	33.20	1199
Difference		−7.1	+7.88	−0.25	−303
IV	0.0	235.1	30.22	30.84	1502
	1.0	229.8	37.60	30.76	1677
Difference		−5.3	+7.38	−0.12	+175
Cow 151	0.0	231.5	33.68	28.74	1330
	0.8	231.8	33.12	28.43	1273
Difference		+0.3	−0.56	−0.31	−57

about midway between the greatest and the least observed in the trial. The increase in iodine value was least for Group VI, although the same amount of oil was fed as in the case of Group V. Hardness for Group VI declined only 40 grams; it is evident that the decline in hardness which might have been expected as the result of the higher iodine value was very nearly offset by the decline in Reichert-Meissl number. Cow 151 showed an increase of 11.88 in iodine value of her butterfat and the hardness dropped 838 grams, whereas cow 419 showed an increase of 8.21 in iodine value accompanied by a decrease of 216 grams in hardness. In the one case (cow 151) both the unsaturated and the volatile fatty acids increased, while in the other the increase in unsaturation was offset, in part, by a decrease in volatile fatty acids. The saponification values in general followed the changes in Reichert-Meissl numbers, as would be expected.

The mean difference between iodine and thiocyanogen values for the basal ration periods preceding and following the linseed oil feeding was 3.53. In the oil feeding period it was 4.98, showing that linseed oil causes a definite rise in the fatty acids less saturated than oleic acid in butterfat.

d. *Influence of feeding cottenseed oil*—Table 5 also gives the effects of feeding cottenseed oil. Comparable results were obtained for Groups III and IV except for hardness, which increased 175 grams for Group IV and decreased 303 grams for Group III. Cow 151 did not show changes in fat constants of as great a magnitude as either Group III or IV, her butterfat remaining very constant in hardness. It is evident from the results for Groups III and IV that the effect of cottonseed oil feeding on the hardness of the butterfat cannot be predicted from the change in iodine value. When cow 151 was fed cottonseed oil, the butter had a gummy body that was unmistakably different from that produced during corn oil or linseed oil feeding.

The cottonseed oil had very little effect in increasing the fatty acids less saturated than oleic acid, judging from the difference between the iodine and thiocyanogen values of the butterfat of cow 151. In the period preceding the oil feeding the difference was 3.05 and in the oil feeding period it was 3.15.

e. *Influence of feeding tallow*—The results of adding one pound of tallow to the basal ration are given in Table 6. It is evident that the tallow depressed the saponification value, with but little change in iodine value or Reichert-Meissl number. This points to an increase in the non-volatile saturated fatty acids since the saponification value decreased without an alteration in the iodine value. The melting point and hardness were increased, but not to the same degree in each case.

f. *Influence of feeding butterfat*—The oils fed in the preceding experiments were of a very different composition than butterfat. These oils had a low saponification value, high iodine value, and no volatile fatty acids. Tallow did not have such a high iodine value, but the saponification value was low. Butterfat was fed in an attempt to determine the effect of feeding a fat containing all the fatty acids of the resulting product.

It will be observed in Table 6 that feeding rendered butterfat brought about some very significant changes in the properties of the butterfat produced. The iodine value decreased 1.69 for Group IV and increased 0.46 for Group III. The average decline in saponification value was 3.0 with a decrease in Reichert-Meissl number of 0.62. Melting point and hardness were augmented most. These changes are much greater than those observed for tallow feeding. The small drop in saponification value indicates an increase in saturated acids, since the iodine value did not increase appreciably. The changes in fat constants fail to explain the differences observed in melting point or hardness of the butterfats obtained.

TABLE 6

The effect of feeding tallow, butterfat and coconut fat on the chemical and physical constants of butterfat

Group	Amount fat fed lbs.	Chemical constants			Physical constants	
		Saponification value	Iodine value per cent	Reichert-Meissl number	Melting point ° C.	Hardness grams
	Tallow					
III	0.0	237.5	31.44	29.35	33.50	1430
	1.0	229.8	32.61	29.59	34.35	1651
Difference		−7.7	+1.17	+0.24	+0.85	+221
IV	0.0	235.2	30.60	30.60	33.00	1730
	1.0	230.2	30.71	30.71	34.35	1745
Difference		−5.0	+0.11	+0.11	+1.35	+15
	Butterfat					
III	0.0	233.4	28.90	28.83	33.50	1815
	1.0	230.0	29.36	28.63	35.25	2246
Difference		−3.4	+0.46	+0.20	+1.75	+431
IV	0.0	234.0	29.47	30.36	32.95	1675
	1.0	231.5	27.78	29.15	35.45	2389
Difference		−2.5	−1.69	−1.21	+2.50	+714
	Coconut fat					
151	0.0	233.4	29.25	29.00		1791
	0.8	238.4	24.65	29.22		2210
Difference		+5.0	−4.60	+0.22		+419
419	0.0	232.8	32.45	29.37		1212
	1.0	235.9	28.96	28.96		1743
Difference		+3.1	−3.49	−0.41		+531

The body of these butters was firm but not hard or brittle.

g. *Influence of feeding coconut fat*—The preceding experiments have shown the effects on the fat constants produced by feeding oils of fats having a wide range of iodine values. It was therefore considered important to include in further experiments a highly saturated fat. Coconut fat contains only 6–10 per cent oleic acid and approximately one per cent of linoleic acid. It also has a higher saponification value than the oils or fats fed in the foregoing experiments. The data presented in Table 6 give the individual results following the feeding of coconut fat. The iodine value was depressed 4.6 for cow 151 and 3.49 for cow 419, the saponification value increased 5.0 for cow 151 and 3.1 for cow 419, and the hardness of the butterfat increased 419 grams for cow 151 and 531 grams for cow 419. These butters were very hard and brittle, especially that from cow 151, which was somewhat crumbly. The structure of the butterfat in these butters appeared to be almost crystalline when they broke at temperatures of 54 degrees F.

Thiocyanogen values were also determined in connection with the coconut fat feeding. The average differences between iodine values and thio-

cyanogen values for the two cows were as follows: For the basal periods, 2.87; for the coconut fat feeding, 2.41. The results indicate some decrease in acids less saturated than oleic due to feeding coconut fat.

h. *Influence of feeding cane sugar*—In the experiments so far reported the effects of various oils and fats on the composition and properties of butterfat were studied through the addition of the oils and fats to the basal ration. This also involved an increase in digestible nutrients of the ration in a special form. In order to determine the effects of the addition of the same amount of nutrients in other forms, an experiment was conducted in which cane sugar was added to the basal ration. It was hoped that this experiment would also assist in interpreting the data reported in the literature relative to the relation of easily fermented carbohydrates in food to the formation of the volatile fatty acids in butterfat. The results in Table 7 show an average increase in saponification value of 2.0, in Reichert-Meissl number of 0.92, and in hardness 146 grams. The iodine value changed but slightly, decreasing 0.64. The increase in hardness corresponds with the slight decrease in iodine value.

TABLE 7

The effect of feeding cane sugar on the chemical constants and hardness of butterfat

	Amount fed lbs.	Chemical constants			Physical constants	
		Saponification value	Iodine value per cent	Reichert-Meissl number	Melting point ° C.	Hardness grams
Group III	0.00	233.4	28.03	28.33	33.20	1611
	2.25	237.0	27.10	30.66	33.10	1735
	Difference	+3.6	−0.93	+2.13	−0.10	+124
Group IV	0.00	236.2	27.87	30.99	33.10	1798
	2.25	236.6	27.42	30.70	33.40	1947
	Difference	+0.4	−0.35	−0.29	+0.30	+149

The Effect of Including Pasture in the Ration

Analyses were made of the butterfat from the University herd previous to turning onto grass and for two weekly periods thereafter. This change is shown in Table 8. The effect was a decrease in saponification and Reichert-Meissl numbers of 2.2 and 0.43 respectively with an increase in iodine value of 3.17. No difference was found in the hardness of the butterfat.

Two cows, 151 and 419, were removed from pasture during the summer in order to throw further light on the effect of pasture on the character of the butterfat. Table 8 shows the results from these two cows. The average effects were as follows: the saponification value increased 2.15, the Reichert-Meissl number decreased 0.20, and the hardness increased 372 with a decrease in iodine value of 3.77. The changes observed in this

TABLE 8

The effect of including pasture in the ration on the chemical constants and hardness of butterfat

Sample	Ration	Chemical constants			Hardness grams
		Saponification value	Iodine value per cent	Reichert-Meissl number	
Station herd	Station ration	229.7	35.25	29.08	952
	Pasture and herd ration	226.5	38.42	28.65	951
	Difference	−2.2	+3.17	−0.43	−1
419	Pasture and herd ration	224.3	43.18	27.40	606
	Basal	226.6	40.18	27.85	657
	Difference	+2.3	−3.00	+0.45	+51
151	Pasture and herd ration	231.8	34.65	29.06	990
	Basal	233.8	30.11	28.30	1684
	Difference	+2.0	−4.55	−0.86	+694

experiment, which may be attributed to grass, are much less than those reported in the literature.

The Composition and Properties of Six Commercial Samples of Butter

The experiments recorded in the preceding pages have shown that certain factors produced butterfat of a low iodine value exhibiting hard characteristics. It seemed of interest to compare these results with those from samples of butter obtained from regions where similar body defects have been reported. Normal samples were also obtained for comparison. Five of these samples were made available through the courtesy of Dr. G. H. Wilster of the Oregon Agricultural Experiment Station, the other by Mr. Al Forte from the Mandan Creamery, North Dakota. The chemical constants and history of the samples are given in Table 9.

The data reveal considerable difference in the hardness of the butterfats with only a slight range in the iodine value. The hard butters (1, 2, and 5) were from sections in which Jerseys are the predominating breed and alfalfa hay is fed in large quantities. The grain ration is made up largely of barley and millrun, a small quantity of linseed meal being included in the concentrate for part of the herds. Sample 3 apparently was influenced by the fall pasture; in addition, the mixed grains contained a considerable quantity of oats. It is evident from the hardness studies and the comments on the butters that those samples associated with alfalfa feeding are most abnormal. However, barley was included in the grain ration for the herds from which the samples were produced. Furthermore, Jerseys were the predominating breed. Breed exerts a definite influence on hardness of butter as shown by Coulter and Hill (8).

TABLE 9

The chemical constants, hardness, body criticisms and history of six commercial samples of butter

Sample number	Body criticism	Chemical constants			Hardness grams
		Saponification value	Iodine value per cent	Reichert-Meissl number	
1	Slightly crumbly and brittle	231.5	32.48	26.93	1951
2	Sticky	230.1	31.10	26.44	1860
3	Normal	226.9	33.43	27.44	1261
4	Normal but firm	230.3	31.89	29.95	1471
5	Slightly crumbly	231.8	30.69	27.33	2214
6	Normal but firm	228.9	32.58	27.38	1423

History of samples

Sample number	Place made	Breed of cows		Feeds
		Predominating	Others	
1	Klamath County, Oregon	Jersey	Red cows	Alfalfa hay, cull potatoes, barley, millrun, and linseed meal.
2	La Grande, Ore.	Jersey	Shorthorns	Alfalfa, corn, silage, barley, millrun, and linseed meal.
3	Gray's River, Washington	Jersey and Guernsey		Grass hay, mixed grain, fall pasture.
4	Corvallis, Ore.	Jersey		Oats and vetch hay, clover hay, mixed silage, kale, millrun chief concentrate.
5	Redmond, Ore.	Jersey		Alfalfa hay, barley, millrun,[1] and linseed meal.
6	Mandan, N. Dak.	Mixed cows all breeds		Mixed hay (chiefly prairie) and corn.

[1] Millrun is made up of the by-products of flour manufacture consisting of bran, middlings, and in some cases ground screenings.

DISCUSSION

Changing from the Experiment Station herd ration, consisting of the herd grain ration, alfalfa hay, and corn silage, to the experimental ration and timothy hay or alfalfa hay, exerted a very profound influence on the characteristics of the butterfat. The averages of the effects were: The iodine value declined 4.49, the Reichert-Meissl number declined 1.01, but the melting point and hardness increased 1.82 degrees C. and 748 grams, respectively. The only change of any significance in the nutrients supplied was a decrease of 0.198 pounds of fat daily. This decrease in amount of fat in the ration was apparently responsible for producing the hard butters observed in both groups.

The fat constants, hardness, and melting point of butter obtained when using timothy hay, alfalfa hay, and beet pulp were not significantly different. It is evident that the fat from each of these feeds exerts an equal effect on the composition of butterfat when fed in combination with a low fat grain mixture. These feeds produced a hard butter not conforming to the characteristics usually associated with superior butter.

Increasing the alfalfa in the ration to such an extent that 85 per cent of the total digestible nutrients were supplied from it brought about rather marked changes in the butterfat of one Holstein cow used in the test. The chief effect was an increase of 4.36 in the iodine value and a decrease of 252 grams in the hardness of the butterfat. The Reichert-Meissl value decreased 1.64. These changes in iodine value conform closely to those reported by Richardson and Abbot (9) for butterfat from cows restricted to alfalfa feeding. However, these workers report a "sticky" body for these butters which was not found in the experiment reported here.

Including pasture in the herd ration resulted in an increase of 3.17 in the iodine value without any effect on the hardness of the butterfat. With two individual cows the reverse procedure, *i.e.*, removal of the cows from pasture to the basal ration, decreased the iodine value and increased the hardness of the butterfat, especially when the decrease in iodine value was accompanied by a decrease in Reichert-Meissl number.

The results with the cereals demonstrate that the effect of corn, oats, and barley are due to the character and amount of the fat they contain. Table 3 shows conclusively that barley feeding resulted in the production of a hard butter, whereas corn and oats produce butters with a desirable body and firmness. Corn oil, when added to the barley-bran ration in quantities equivalent to the difference between the oil content of the barley plus bran and the corn plus bran rations, brought about results very similar to those produced when corn was fed. These experiments were undoubtedly influenced somewhat by outside factors not under control; however, the results are sufficiently consistent to justify the above conclusion.

The literature appears to show that the iodine value of the oil in a feed or ration will be directly responsible for the hardness of butterfat. This apparently holds true insofar as certain oils are concerned, but does not hold true in all cases. It is true that the iodine value of the ration fat largely determines the iodine value of the butterfat. For example, linseed oil increased the iodine value most with corn oil and cottonseed oil following rather closely. Both tallow and butterfat being about equally unsaturated had but slight influence on the iodine value of the butterfat. Coconut oil being very highly saturated produced a butterfat having a lower iodine value and higher saponification value than did the basal ration. Considering that the above oils were added to a ration already supplying sufficient total digestible nutrients to satisfy the requirement, it

is very evident that these oils modified the fat forming processes already going on in the animal body.

However, the oils and fats in feed do not influence the hardness of butterfat to the same degree that they affect the iodine value. Corn oil influenced the hardness equally as much as the linseed oil. Examination of the butter produced during the feeding of linseed oil revealed a somewhat firmer body than that produced during corn oil feeding. The butter from corn oil feeding tended to be somewhat softer and mushy. Cottonseed oil, on the other hand, increased the iodine value but did not appreciably decrease the hardness except with one group of cows; furthermore, the body of the butter was gummy and sticky and did not melt easily when tasted. Tallow did not appreciably alter the composition of the fat or the hardness of the butterfat. Butterfat feeding likewise did not alter the iodine value or Reichert-Meissl number to any marked extent; however, it did increase very markedly the melting point and the hardness of the fat. The butters in these cases were tough but not brittle, indicating further change in the structure of the triglycerides.

Recent experiments by Schoenheimer (12) may explain the failure of the volatile fatty acids fed in the butterfat feeding periods to appear in the milk fat. Using deutero-fatty acids to trace their fate after ingestion, he reports that butyric and caproic acids are completely oxidized (by mice) and only higher fat acids are deposited.

Coconut fat unmistakably decreased the iodine value of the butterfat, increased the saponification value, and markedly increased the hardness of the butterfat. The change observed was dependent on the initial properties of the butterfat; since cow 419 was producing a relatively normal fat on the basal ration, the addition of coconut fat did not produce a butter exhibiting a body of a firmer character than might be expected from feeding a low fat diet. In contrast, cow 151, already producing a relatively hard butter, produced a very hard, brittle butter, approaching crumbliness, following the coconut oil feeding. This butter was nearly the hardest produced during the experiment. The fats had iodine values very similar to those observed in the roughage feeding tests; however, the other characteristics of the fat were considerably different.

The feeding of sugar had no discernible effect on the fat constants. The hardness was increased slightly but not sufficiently to be of any real importance, thus further supporting the assumption that the fat is a more important factor influencing butterfat composition than the energy supplied.

The discussion concerning the hardness of butterfat and the iodine value tends to emphasize certain specific effects for feeds other than those exerted on the iodine value. Generally speaking it is possible to deduce from Coulter and Hill (8) that there is a highly significant relationship between iodine value and hardness of butterfat. The index of correlation was 0.85 with less than one chance in 100 that this value could come from chance.

Cottonseed oil feeding gave hardness values entirely out of line with the iodine value, especially in the group feeding tests.

Hilditch and Sleightholme (13) and Banks and Hilditch (14) have discussed the importance of the saturated triglycerides in feed imparting to animal fats their characteristic properties such as melting point and consistence. In all the samples reported by these workers the fully saturated portions of the butterfat were very similar in composition. Following the feeding of oils the changes of most importance occurred in the percentage of non-fully-saturated glycerides. When considering these findings in relation to the results obtained in the present study it appears that an increase in non-fully-saturated glycerides, in addition to an increase in the quantity of unsaturated acids present in the portion previously non-fully-saturated, no doubt played an important part in the changes observed in hardness. The decrease in the slope of the curve shown by Coulter and Hill (8) may be explained by a more complete unsaturation of the non-fully-saturated triglycerides. In this case the fully-saturated glycerides could exert a more constant effect in retaining the consistency of the butterfat.

CONCLUSIONS

1. When barley constitutes 35–50 per cent of the digestible nutrients of a low fat ration containing alfalfa or timothy hay, fed to dairy cows, hard butterfat with a low iodine value is produced.

2. When oats or corn are substituted for 35–50 per cent of the digestible nutrients of a low fat ration, containing alfalfa hay, fed to dairy cows, the physical characteristics of the butter produced are satisfactory from the market standpoint, and the chemical characteristics of the fat are more or less specific for the type of ration fed.

3. When alfalfa hay, timothy hay or beet pulp are fed with a low fat grain ration to dairy cows, they exert a similar effect on the composition and physical properties of butterfat.

4. When oils or fats are fed to dairy cows the resulting butterfat assumes some of the chemical characteristics of the fat or oil fed.

5. When 0.6 pounds or more of linseed oil is fed daily to dairy cows the butterfat produced shows a significant increase in the content of fatty acids less saturated than oleic acid, as judged by the increase in difference between the iodine and thiocyanogen values.

The late Doctor C. H. Eckles suggested this study. His help and criticism in planning and carrying out the investigation is gratefully acknowledged.

REFERENCES

(1) JORDON, W. H., AND JENTER, C. G. The Source of Milk Fat. New York Experiment Station Bulletin 132. 1897.

(2) HILLS, J. L. The Effect of Feed on the Quality of Butter. Vermont Agricultural Experiment Station Report 375–377. 1901.

(3) LINDSEY, J. B. The Effect of Feed upon the Composition of Milk and Butterfat, and upon the Consistency or Body of Butter. Massachusetts Agricultural Experiment Station Annual Report 109–112. 1907.

(4) BUSCHMANN, A., AMTMANN. J., AND SPANDEG, L. Untersuchungen über den Anteil der Kohlenhydrate des Futters an der Bildurg des Milchfettes und Milchzuckers. Zeitschrift für Zuchtung **10**: 47. 1927.

(5) HANSSON, NILS, AND OLOFSSON, N. E. Fortgesetzte Untersuchungen über den Einfluss der Futtermittel auf die Konsistenz der Butter. Beidermanns Zentr. B. Tierernahr, **3**: 352–391. 1931.

(6) MAGI, J. Der Einfluss Einiger Futtermittel Auf Die Qualität der Butter. XI. Milchwirtschaftlicher Weltkongress, Band II, pages 133–137. Berlin, 1937.

(7) HANSEN, A. P., AND STENSBURG, V. Nogle Fordermidlers Indflydeke Paa Smørrets Konsistens m.m., 134te Beret Forsøgslab. K. Vet. og Landbohøjskoles, **134**: 1–133. 1930.

(8) COULTER, S. T., AND HILL, O. J. The Relation between the Hardness of Butter and Butterfat and the Iodine Number of the Butterfat. JOURNAL DAIRY SCIENCE, **18**: 543–550. 1934.

(9) RICHARDSON, G. A., AND ABBOT, F. H. Prevention of the Defect in the Consistency of Butter Due to an Alfalfa Hay Ration. Proceedings 21st annual meeting Western Division American Dairy Science Association, Portland, Oregon, pages 63–69, 1935.

(10) KAUFMANN, H. P. Die Rhodanometrie von Fetter und Fettgemischen. Ztschr. Untersuch. Nahr, U. Genussmtl, **51**: 51–57. 1926.

(11) ZELENY, L., AND BAILEY, C. H. Thiocyanogen Number and Its Application to Studies on Lard. Indus. and Engin. Chem. **24**: 109. 1932.

(12) SCHOENHEIMER, R. Studies in the Intermediate Metabolism of the Fatty Acids with Deuterium as Indicator. Jour. Biol. Chem. 119; Proceedings LXXXVII, 1937.

(13) HILDITCH, T. P., AND SLEIGHTHOLME, J. L. Variation in the Component Fatty Acids of Butter Due to Changes in Seasonal and Feeding Conditions. Biochem. Jour. **24**: 1098–1113. 1930.

(14) BANKS, A., AND HILDITCH, T. P. XXXIV. The Body Fats of the Pig. II. Some Aspects of the Formation of Animal Depot Fats Suggested by the Composition of Their Glycerides and Fatty Acids. Biochem. Jour. **26**: 298–308. 1932.

SOME CAUSES FOR THE DETERIORATION IN 10 DAYS AT 15.5° C. OF SALTED BUTTER MADE FROM SOUR CREAM[1]

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Much research work (4, 5, 9, 10, 11) has been done on the problem of keeping quality of butter in commercial cold storage; however, less consideration (6, 13) has been given to keeping quality of the butter while it is in the various trade channels and in the home of the consumer where it may be held for periods of time at temperatures far too high for satisfactory butter storage. During this time, when at relatively high temperatures, some butter preserves its flavor while in other butter the flavor deteriorates. In order to determine some of the causes of these flavor changes, this study was undertaken.

An explanation of the possible causes of deterioration in flavor have been bacteria, yeasts, molds, the inherent enzymes of the milk, and chemical action taking place within the constituents of butter.

For this study a number of samples of typical centralizer butter made in Indiana and neighboring states were available. In addition to the microbiological analyses, each sample was scored when obtained and given a keeping quality test which consisted of holding the butter for 10 days at 15.5° C. and then rescored. The scoring was done by Dr. B. E. Horrall and the scores were then checked by the authors individually and average scores recorded. The butter was examined bacteriologically, after incubation, in an effort to determine some of the factors that were involved in its deterioration.

THE KEEPING QUALITY OF SALTED BUTTER MADE FROM SOUR CREAM

In this study 504 samples were examined. The butter was manufactured in a nine-month period starting September, 1936 and the number of samples received each month was approximately the same and from the same creameries. The drop in score in samples of butter during the 10 day holding period at 15.5° C. is shown in Table 1.

It may be assumed that butter which does not decrease in score more than one point will stand up under the conditions of refrigeration used by distributors and consumers. As shown in Table 1, 25 per cent of the samples

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[1] The data in this paper was taken in part from a thesis presented by J. C. Flake in partial fulfillment of the requirement for the Master of Science degree, and is published with the approval of the Director of the Agricultural Experiment Station.

TABLE 1

The keeping quality of salted butter made from sour cream as indicated by change in score after 10 days at 15.5° C.

	Drop in score in points				
	0	0.5–1	1.5–2	2.5–3	3.5 or more
Number of Samples	163	214	73	39	15
Percentage of Samples	32	42	14	8	3

decreased in score more than one point and 11 per cent decreased 2.5 points or more in score.

TABLE 2

The drop in score of butter after holding for 10 days at 15.5° C. according to the original score of the same butter

	Original Score			
	91 or more	90.5–90	89.5–89	88.5 or less
Number of Samples	31	157	255	63
Average Drop in Score	2.0	0.86	0.60	0.68
Per Cent not Dropping in Score	0	27	38	37

In Table 2 the data are presented to show the influence of the original score of the butter upon its keeping quality as measured by the method used. The bulk of the samples examined had original scores between 90.5 and 89. However, in the butter scoring 91 or more, the deterioration was so consistent that the results are significant in that no sample was found which did not decrease in score and this average decrease was 2 points. The decrease in score of the butter scoring 90.5 to 90 was 0.86 points and 27 per

TABLE 3

Relation of the month of manufacture to the drop in score of butter

Month 1936–37	No. of Samples	0–5	Percentage of samples decreasing in score	
			1–1.5 points	2 or more points
September	54	30	48	22
October	59	27	54	19
November	61	44	41	15
December	60	40	42	18
January	57	30	47	23
February	53	37	47	16
March	50	48	38	14
April	61	69	23	8
May	52	47	38	15

cent of the samples retained their original score. Butter which scored below 88.5 showed approximately the same drop in score and with the same percentage of samples decreasing in score as did butter scoring 89.5 to 89.

In Table 3 are presented data showing the relation of the month in which the butter was manufactured to decrease in score in 10 days at 15.5° C.

The butter manufactured during the colder months of the year showed no significantly better keeping quality than butter made in the fall or spring. In January, butter of the poorest keeping quality was manufactured, while in April the butter of the best keeping quality was manufactured of the months studied. However, in May, the keeping quality decreased approaching the median for the period.

THE INFLUENCE OF THE MICROBIOLOGICAL CONTENT OF THE BUTTER UPON ITS KEEPING QUALITY

In that butter consists of 80 per cent fat, which is an inert material to many micro-organisms, it presents a microbiological problem entirely different from that of other dairy products. This is further emphasized by the fact that butter is an emulsion of water in fat, while in milk and most other dairy products the water is the continuous phase.

It was deemed advisable to study the general microscopic picture of the butter flora to determine whether or not micro-organisms were the cause of the decrease in score. This was done by preparing a sample of centrifugally separated serum using the method developed by Hammer and Nelson (3) and staining with the technique of Newman (7).

The examination of 103 samples of butter which had dropped from zero to four points in score during the holding period revealed that there was a limited relation between the microscopic picture and the decrease in score. In general, it was found that large numbers of rod-shaped organisms were found in butter having poor keeping quality. These results are similar to those reported by Nelson (6). No relation was found to exist between the decrease in score and the numbers or arrangement of cocci contained in the smear of butter serum.

Previous workers (2, 11, 12) have endeavored to determine the influence of proteolytic and lipolytic organisms upon the keeping quality of butter by enumerating the numbers of these organisms in freshly manufactured butter. Since there are a number of factors other than time and temperature of incubation which affect the growth of micro-organisms in butter, a study was made to determine the numbers of proteolytic organisms in the butter at the end of the holding period of ten days at 15.5° C.

At the conclusion of the holding period, the samples of butter were plated on tryptone-skim milk agar for the purpose of detecting proteolytic organisms. The composition of the medium used, as modified from the casein containing medium suggested by the American Dairy Science Association

Sub-Committee on Microbiological Methods of Examining Butter (8), was as follows: 0.5 per cent tryptone, Difco; 1.5 per cent agar agar; 5.0 per cent skim milk, added just before pouring plates. The final pH was 6.8 to 7.2. Incubation was for five days at 21° C. Proteolytic colonies were judged by their appearance and when in doubt the plates were flooded with five per cent tannic acid.

The results from 101 samples selected at random from the 504 samples are shown in Table 4, with the counts tabulated according to drop in score of the butter. The samples which dropped less than one and one-half points in score had comparatively low logarithmic average proteolytic counts. The averages for the samples which dropped two to two and one-half points are

TABLE 4

Relation of proteolytic bacterial count to drop in score of butter held for ten days at 15.5° F.

	Drop in Score in Points							
	0	1	1.5	2	2.5	3	3.5	4 or more
Number of Samples	22	9	18	22	8	12	4	6
Logarithmic Average of Proteolytic Counts	9,250	2,350	5,000	31,000	23,000	7,500	4,000	32,000
Proteolytic Bacterial Counts of 100,000 or more —per cent	4.5	11.0	5.6	36.4	50.0	16.7	25.0	50.0

much higher, as is true for those which dropped four or more points. However, the samples which dropped three to three and one-half points show low proteolytic counts, being similar to the samples which had only a slight drop in score. The reason for these low counts is difficult to explain, especially in view of the limited number of samples. The organisms may have died off while the butter was being incubated because of limited food or because of the presence of poisonous products of metabolic activity. The deterioration may have been more concerned with chemical than with biological causes. Another possibility is that the right balance of associative action was present in order to cause marked deterioration although the actual proteolytic counts were low.

Table 4 is even more significant when the distribution of the counts of 100,000 or more proteolytic organisms per ml. are examined. Further tabulation shows that, of the samples dropping less than two points, only 6.1 per cent had counts of 100,000 or more, while of the samples which dropped two or more points, 34.6 per cent had counts falling within this range.

It is believed that proteolytic organisms are an important factor in the development of putrid flavors in butter. It was found that the samples which developed this flavor during the holding period had higher proteolytic counts than did the samples which developed other off flavors. Thirty-three and six-tenths per cent of the samples which developed putrid flavors had proteolytic counts of 100,000 or more. Of those which developed rancid flavors, old cream flavors, and those which did not change in score, 16.6, 11.1, and 4.5 per cent respectively, had proteolytic counts of 100,000 or more.

The samples were also plated at the end of the ten day holding period for the enumeration of lipolytic micro-organisms. Tributyrin agar and nile blue sulfate agar were used. Incubation was for five days at 21° C.

The tributyrin medium, as modified from that suggested by Anderson (1), consisted of Standard Nutrient Agar base, plus 0.1 per cent sodium taurocholate, plus 1.0 per cent tributyrin. The final reaction was pH 6.8 to 7.2.

The nile blue sulfate medium, as modified from the one suggested by the American Dairy Science Association Sub-committee on the Microbiological Methods of Examining Butter (8), consisted of 0.5 per cent tryptone (Difco), 1.5 per cent agar agar, 0.5 per cent skim milk, 5.0 per cent of a 0.1 per cent nile blue sulfate solution, and 10.0 per cent of a butterfat emulsion containing 4.0 per cent butterfat and 0.5 per cent agar agar. The sterile fat emulsion and skim milk were added just before pouring the plates. The final reaction of the medium was pH 6.8 to 7.2.

The results of plating these samples of butter on the two media for the detection of lipolytic bacteria are given in Tables 5 and 6.

TABLE 5

Relation of lipolytic count on tributyrin medium to drop in score of butter held for ten days at 15.5° C.—Total of 63 samples

Drop in Score	0	1	1.5	2	2.5	3	3.5	4 or more
No. of Samples	16	6	9	10	5	9	3	5
Log. Av. of Counts	120,000	150,000	130,000	890,000	480,000	590,000	1,350,000	680,000

Table 5 shows a very marked relation between high lipolytic counts on tributyrin medium and poor keeping quality during the ten day holding

TABLE 6

Relation of lipolytic bacterial count on nile blue sulfate medium to drop in score of butter held for ten days at 15.5° C.—Total of 101 samples

Drop in Score	0	1	1.5	2	2.5	3	3.5	4 or more
No. of Samples	22	9	17	22	9	12	4	
Log. Av. of Counts	7,400	9,200	21,500	117,500	17,000	38,000	26,000	2,050

period. Further tabulation gives a logarithmic average of 127,000 per ml. for the samples which dropped less than two points, while those which dropped two or more points had a logarithmic average count of 700,000 per ml. of butter.

Table 6 shows a marked tendency for high lipolytic counts on nile blue sulfate medium to be associated with poor keeping quality, except in the case of those samples which decreased 4 or more points in score. There is, however, a less direct relation between lipolytic count and keeping quality when this medium is used than when the tributyrin media was used.

SUMMARY AND CONCLUSIONS

The data presented show that salted butter made from sour cream presents a problem as far as keeping quality at 15.5° C. is concerned. Twenty-five per cent of the 504 samples received from September to May dropped at least one and one-half points in score. This deterioration was found among the samples submitted by a large number of different creameries.

The samples which had an original score of 89 to 89.5 points had better keeping quality than did higher scoring butter and slightly better keeping quality than did the butter which scored less than 89. The month in which the butter was made did not significantly influence its deterioration.

A limited relation between the microscopic picture and keeping quality of the butter was found. Large numbers of rod-shaped organisms were, in general, associated with poor keeping quality. There was no relation between keeping quality and numbers or arrangement of cocci.

There was a marked relation between high proteolytic counts on tryptone-skim milk agar and poor keeping quality.

A marked relation was found between high lipolytic counts on tributyrin medium and poor keeping quality. This relationship was less marked when nile blue sulfate medium was used.

REFERENCES

(1) Anderson, J. A. An agar plate count for the detection and enumeration of lipolytic micro-organisms. Jour. Bact., 27: 69. 1934.

(2) Guthrie, E. S., Scheib, B. J., and Stark, C. N. The effect of certain factors upon the keeping quality of butter. Jour. Dairy Sci., 19: 267–278. 1936.

(3) Hammer, B. W., and Nelson, J. A. Bacteriology of butter. Iowa Agric. Exper. Sta. Res. Bull. 137. 1931.

(4) Herreid, E. D., Macy, H., and Combs, W. B. The microbiology of cheese-like flavors in unsalted butter. Minn. Agric. Sta. Tech. Bul. 97. 1934.

(5) Loftus-Hills, G., Scharp, L. R., and Bellair, T. S. A study of factors influencing the keeping quality of some victorian salted butters in cold storage. Jour. Dairy Res. 5: 124–136. 1934.

(6) Nelson, J. A. The correlation between the organisms found microscopically and the bacteriological deterioration of butter. Montana Agric. Exper. Sta. Bull. 267. 1932.

(7) NEWMAN, R. W. A one solution technique for the direct microscopic method of counting bacteria in milk. The Monthly Bull. Cal. State Dept. of Agric. 16: 1–7. 1927.

(8) PARFITT, E. H. Sub-committee on Microbiological Methods of Examining Butter. The microbiological analysis of butter. JOUR. DAIRY SCI., 16: 289–299. 1933.

(9) RAHN, OTTO, BROWN, C. W., AND SMITH, L. N. Keeping qualities of butter. Mich. State College Agric. Exper. Sta. Tech. Bull. 2. 1909.

(10) RUEHLE, G. L. A. Keeping qualities of butter. Mich. State College Agric. Exper. Sta. Tech. Bull. 102. 1930.

(11) SPITZER, G., PARFITT, E. H., MANHART, V. C., AND EPPLE, WM. F. Proteolytic study of the action of specific organisms and groups of organisms in butter made from graded cream. Purdue Univ. Agric. Exper. Station Bull. 319. 1927.

(12) STARK C. N., AND SCHEIB, B. J. A study of fat splitting and casein digesting bacteria isolated from butter. JOUR. DAIRY SCI., 19: 191–213. 1936.

(13) SUTTON, W. S. A bottle test for detecting certain butter defects. Agric. Gaz. of New South Wales, 40: 244–248. 1929.

THE CORRELATION BETWEEN ORGANISMS FOUND MICROSCOPICALLY IN BUTTER SERUM AND THE GRADE OF CREAM FROM WHICH THE BUTTER WAS MADE

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Quality in butter is becoming a more important issue to the industry each year. Since butter quality depends on the grade of cream, the cream usually has been graded in accordance with the kind of butter it will make. Grading is accomplished by the senses of taste and smell. In this study an attempt was made to determine the grade of cream by a microscopic examination of the organisms in the butter serum. This also included studies on varied lengths of storing butter, effects of culture, and a possible relationship between specific flavor defects and certain micro-organisms. Not all deterioration of cream is bacteriological so the grade may be lower than the organisms and their action would indicate.

PREVIOUS INVESTIGATIONS

Nelson (1) studied microscopic slides of butter with the view of predicting its keeping quality during storage for 7 days at 21° C. Clumps of well stained thin rods were generally a sure sign that deterioration would take place, especially in unsalted butter. The keeping quality was correctly predicted on 96.4 per cent of the commercial salted samples, 79.6 per cent of the unsalted and 84.9 per cent of the exhibition butter.

Nelson and Hammer (2) found that butter culture streptococci generally developed little or not at all in salted butter held at a favorable growth temperature. Organisms other than streptococci sometimes showed growth, this growth depending on the species present. In unsalted butter both streptococci and organisms other than streptococci developed at a favorable temperature.

Macy, Coulter and Combs (3) obtained decreased counts on salted butter held for 30 days; molds 66.7 per cent, yeasts 80 per cent and 73.3 per cent for bacteria. These decreases did not follow a consistent pattern.

PROCEDURE

Cream of all grades was procured and scored by two experienced judges according to the grade of butter it would make. Sweet and clean cream which should produce butter scoring 93 or above was graded "excellent," clean and sour cream scoring 91½ to 92½ was graded "good," and cream graded "fair," which scored 90 to 91 was sour with some off flavor. Cream

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scoring below 90 was graded "poor." After scoring a microscopic slide was prepared from each sample. The cream was pasteurized at 68 to 71° C., held for 30 minutes, cooled to 7° C., held over night at 4° C., churned in a small experimental churn, buttermilk drained, butter washed, salted and worked. A sample of butter was then taken in 4 ounce bottles and held at 4° C. until slides were prepared of it.

Cream slides were prepared by the Fay (4) method. It consisted of 0.1 ml. of cream, one drop of sterile water, and one drop of Mayer's egg-glycerine mixture spread on one-half the surface of a slide. This was dried, dipped in alcohol for 20 seconds, dried and immersed in xylene for two minutes, dried and stained for one minute in methylene blue. Butter slides were prepared according to Nelson and Hammer (5). Melted butter was centrifuged in a separatory funnel and the non-fatty layer, serum, drained. One hundredth of a ml. was spread over 1 square centimeter, dried, stained with Newman stain (6), washed, dried, and restained with methylene blue.

RESULTS

One hundred and thirty samples were studied in the preliminary work to acquire a knowledge of the microscopic appearance of butter slides for the grades of cream "excellent," "good," "fair," and "poor." The following appearances of butter slides were correlated with the various grades of cream: (1) Butter from "excellent" grade cream showed a few well stained micro-organisms. Those present were cocci singly, in pairs, or chains. The use of culture increased the number of organisms present. No rods and only a very few yeasts were ever seen. (2) Slides of butter from "good" cream had a large number of well stained micro-organisms most of which were cocci singly, in pairs, or chains. A very few partly decomposed cells, occasionally occurred and a very few yeasts or molds. (3) "Fair" grade cream gave butter whose slides had an exceedingly large number of well stained micro-organisms. Most were cocci singly, in pairs, and in chains. The slides frequently showed many poorly stained and partly decomposed cells, a few rods, yeasts, and molds. (4) Slides from butter made of "poor" grade cream had a large to enormously large number of organisms, a majority of these were stained poorly and partly decomposed. Often slender rods existed; many times yeasts and molds were present.

The results of the study were grouped according to the grade of cream. On table 1 are tabulated the studies of butter made from cream scoring "excellent." A total of 143 different samples of butter was examined, of which 33 were stored for 1–3 days before preparing the slides. The grade was determined correctly by the microscopic examination on 90.9 per cent of the samples. For the 7–day holding, 95.4 per cent of 22 samples were correctly graded. Of the 56 samples held 14 days, 89.3 per cent were graded rightly. The fourth group consisted of 32 samples held 30 days, and 93.7

per cent were graded accurately. The average of the four holding periods was 91.6 per cent correct out of 143 samples. The number of samples of other grades incorrectly called "excellent" was small; 9.6 per cent of 125 in the "good" cream class, 1.8 per cent of 159 in the "fair" class and 4.2 per cent of the 97 "poor" cream samples. This is a total of 4.9 per cent mis-graded as "excellent" from 371 samples.

TABLE 1

Butter churned from "excellent" cream scoring 93 or above

	Storage Period			
	1–3 days	7 days	14 days	30 days
Total Samples	33	22	56	32
Number graded right	30	21	50	30
Number graded wrong	3	1	6	2
Number missed 1 grade	3	1	1	1
Number missed 2 grades	0	0	0	1
Number missed 3 grades	0	0	5	0
Per cent graded right	90.9	95.4	89.3	93.7

Table 2 contains the information on butter churned from "good" cream. Thirty-three samples were held 1 to 3 days and 63.6 per cent were graded correctly, 24 samples held for 7 days and 66.6 per cent graded correctly, 37 samples held 14 days of which 43.2 per cent were graded correctly. In the group held 30 days, 64.5 per cent were graded correctly from 31 samples. The total of the four holding periods amounts to a percentage of 58.4 right from 125 samples. The percentage of other grades incorrectly called "good" were: "excellent" 4.1, "fair" 27.6, and "poor" 19.5, giving a 17.2 per cent total on the three grades.

The tabulations for "fair" cream was recorded on table 3. The group stored for 1 to 3 days contained 57 samples and only 43.9 per cent were

TABLE 2

Butter churned from "good" cream scoring 91½ to 92½

	Storage Period			
	1–3 days	7 days	14 days	30 days
Total Samples	33	24	37	31
Number graded right	21	16	16	20
Number graded wrong	12	8	21	11
Number missed 1 grade too high	1	2	4	5
Number missed 1 grade too low	8	3	5	5
Number missed 2 grades too low	3	3	12	1
Per cent graded right	63.6	66.6	43.2	64.5

accurately graded. In 7 day lots 60.0 per cent were ascertained rightly from 20 samples and 40.0 per cent of the 40 samples in storage 14 days. Forty-two samples were stored in the 30 day lot of which 35.7 per cent were graded correctly. The percentage correctly graded was 42.7 for 159 samples in all four storage groups. Other grades erroneously called "fair" consisted of "excellent" 0.7 per cent, "good" 16.3 per cent and "poor" 22.6 per cent, giving a total of 12 per cent from 365 samples. These results seem to indicate that butter from cream scoring 90 to 91 cannot be accurately graded by the microscopic method. Factors such as chemical action and absorbed flavors apparently have a more important rôle in lowering cream to "fair" grade than was the case in the two higher grades of cream.

TABLE 3

Butter churned from "fair" cream scoring 90 to 91

	Storage Period			
	1–3 days	7 days	14 days	30 days
Total Samples	57	20	40	42
Number graded right	25	12	16	15
Number graded wrong	32	8	24	27
Number missed 1 grade too high	19	3	9	13
Number missed 2 grades too high	2	5	15	1
Number missed 1 grade too low	11	0	0	13
Per cent graded right	43.9	60.0	40.0	35.7

Table 4 shows the results for cream scoring below 90, "poor" grade. Seventeen samples were held 1 to 3 days and 47.0 per cent graded properly. Of the 10 held 7 days 70 per cent were given the correct grade. For 14 days 62 samples were stored, of which 54.8 were graded accurately. A percentage of 38.5 was corretly graded for the 8 samples stored 30 days.

A summary of the four groups shows that 97 samples were examined and

TABLE 4

Butter churned from "poor" cream scoring below 90

	Storage Period			
	1–3 days	7 days	14 days	30 days
Total Samples	17	10	62	8
Number graded right	8	7	34	3
Number graded wrong	9	3	28	5
Number graded 1 grade too high	8	1	11	2
Number graded 2 grades too high	1	1	15	2
Number graded 3 grades too high	0	1	2	1
Per cent graded right	47.0	70.0	54.8	38.5

53.6 per cent of these correctly graded. The "excellent" grade erroneously ascertained as "poor" was 3.4 per cent, "good" 15.1 per cent and "fair" 27.6 per cent, making a total of 15.9 per cent for 427 samples. The microscopic examination was successful in determining the grade for "poor" cream in only about fifty per cent of the cases. This was explained by the fact that many times a large number of the micro-organisms had completely decomposed, thus giving the appearance of a higher grade.

Altogether 524 samples composed the entire study of the four grades. The percentage determined correctly equaled 61.8.

A comparison was conducted on the same butter, one sample held 1 to 3 days and the other 30 days. A total of 103 churnings was studied consisting of "excellent" "good" and "fair" grades. In both storage periods the same percentage of 62.2 was graded correctly, indicating neither holding period was advantageous. A change occurred in the butter micro-flora during the 30 day holding, but this change caused some samples to be graded correctly that were missed in the 1 to 3 day storage and vice versa.

Culture organisms were added to approximately half the entire samples studied. The conclusions drawn from the results on the four grades indicated that the presence or absence of culture organisms did not influence the accuracy of the microscopic determinations. The number of culture organisms was considerably greater in butter from "excellent" cream than from "fair" cream when adding the same amount. This seemed to verify the observation that culture has more effect on high quality cream than on poorer cream.

Samples of the "fair" grade were obtained from commercial plant operations to compare with those churned by the laboratory procedure. Of the 55 commercial samples 30.9 per cent were correctly graded and 48.1 per cent of the 106 laboratory samples. The difference was not considered large enough to more than suggest that the commercial samples might be a trifle harder to grade correctly.

A study of the data on butter slides for a possible correlation between certain micro-organisms and specific flavor defect in cream was negative. The only means of distinguishing among the stained micro-organisms was in size, shape, and whether they occurred singly, in pairs, or in clumps. This was insufficient information to correlate organisms with specific flavor defect in the cream.

SUMMARY

The data recorded in the study consisted of sample number, cream score, criticisms of flavor, appearance of the cream slide, and appearance of the stained butter serum.

In the preliminary work 130 samples were studied for the purpose of determining the microscopic appearance of the butter serum. This informa-

tion was correlated with each of the four grades of cream from which the butter was churned. The grades of cream used in making the butter were "excellent" scoring 93 or above, "good" 91½ to 92½, "fair" 90 to 91, and "poor" below 90 in score.

The stained slides of 524 samples of butter were studied under the microscope and the grade of cream predicted. Of these 524 samples, 143 were from the "excellent" group and 131 (91.6 per cent) were given the correct grade. In the "good" group there were 125 samples. Seventy-three (58.4 per cent) were accurately graded. One hundred and fifty-nine samples of the "fair" group were examined and 68 (42.7 per cent) had the right grade predicted. In the last group 52 (53.6 per cent) of the 97 "poor" group samples were graded accurately. This seems to indicate that the microscopic examination was fairly accurate in distinguishing butter made from "excellent" cream, but for lower grades it was not a reliable method.

Storage periods of 1 to 3 days, 7 days, 14 days, and 30 days did not materially influence the number of grades determined correctly. This was verified by a trial in which one-half the samples was held for 1 to 3 days and the remaining samples 30 days. The percentage determined correctly from 103 churnings was the same (62.2) for both storage periods.

The presence or absence of culture organisms did not effect the microscopic grading.

The results on studies of the "fair" group indicated samples from commercial churnings were slightly more difficult to grade correctly than those from the laboratory procedure. This was apparently caused by the difference in handling conditions.

The two apparent reasons for not being able to determine the "good," "fair," and "poor" grades as accurately as the "excellent" grade were: (1) Low scoring cream was not always the result of bacteriological action but was caused by chemical action and absorbed feed flavors. (2) The other reason was the contamination by organisms subsequent to pasteurization of cream and during the churning process.

REFERENCES

(1) Nelson, J. A. The Correlation Between the Organisms Found Microscopically and the Bacteriological Deterioration of Butter. Mont. Agric. Exper. Sta. Bull. 267. 1932.

(2) Nelson, J. A., and Hammer, B. W. Studies on Butter Culture Organisms. Jour. Dairy Sci., 16: 375. 1933.

(3) Macy, H., Coulter, S. T., and Combs, W. B. Observations on the Quantitative Changes in Microflora During the Manufacture and Storage of Butter. Minn. Agric. Exper. Sta. Tech. Bull. 82. 1931.

(4) Fay, A. C. A Method for the Microscopic Examination of Butter. Jour. Dairy Sci. 18: 603. 1935.

(5) Nelson, J. A., and Hammer, B. W. A Method for the Microscopic Examination of Butter. Iowa Agric. Exper. Sta. Res. Bull. 137. 1931.

(6) Newman, R. W. Monthly Bull. Calif. State Dept. Agric. 16. No. 1, 1–6. 1927.

NOTE ON VIOLET RED BILE AGAR FOR DETECTION OF *ESCHERICHIA COLI*

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Since most of the reported work using Violet Red Bile Agar for the detection of *Escherichia coli* has been on a theoretical laboratory scale, herewith is reported a practical application that yielded such satisfactory results that it appears worthy of mention.

A dairy, located in one of the North Central States, was having difficulty with a re-contamination by *Escherichia coli* after the milk received a heat treatment of 170° F. for 30 minutes. The finished product of this dairy could not be marketed unless the material was free from *Escherichia coli*. It was feared that perhaps the organism was getting into the heated milk from the spray pond water which was used as condensing water in the evaporator and dryer. In an attempt to trace this source of *Escherichia coli*, the authors were invited as consultants.

Samples of the milk, secured at various points in the process after the milk had been heated as described above, were tested for the presence of *Escherichia coli*. Two different methods were used for the detection of the organism; namely, (1) inoculating the milk into Brilliant Green Bile Broth 2% Medium for the presumptive test followed by streaking on Eosin-Methylene Blue Agar from the tubes that showed gas production, and, (2) plating the milk directly, using Violet Red Bile Agar as the medium. On the last named medium the organism produces small, purplish red colonies which are surrounded by a zone of precipitated bile after an incubation period of 18 to 24 hours at 37° C.

Over a hundred samples were tested for the presence of *Escherichia coli* and in every instance when typical colonies of this organism developed on the Violet Red Bile Agar in 18 to 24 hours, corresponding, confirmed-positive results were obtained in 48 hours using the other method. On the other hand, when gas was produced in the Brilliant Green Bile Broth which gave a spurious test on the confirmation medium, no typical colonies were produced on the Violet Red Bile Agar, so that, during the practical application of these two methods in the detection of *Escherichia coli*, perfect correlation was obtained.

Using the direct plating method that gave results in 18 to 24 hours as compared to the 48 hours required by the Brilliant Green Bile Broth and Eosin Methylene Blue Agar method, changes could be made within 24 hours after the samples were taken to correct or eliminate conditions that were a

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possible source of re-contamination. Whereas if the results were not obtained before 48 hours, no changes could have been started until two days had elapsed after the samples were taken. Hence much time and expense were saved by accepting the results of the Violet Red Bile plates which enabled the necessary corrections and alterations to be made before the day's manufacturing started thereby maintaining the daily production schedule.

The results obtained raise the question, "When *Escherichia coli* did make its appearance was the recontamination sufficiently heavy to make both of these methods equally sensitive?" In this study no attempt was made to determine the relative sensitivities of these two media. Nevertheless, the fact remains that, using the results obtained with Violet Red Bile Agar to solve the practical problem described, much time and material were saved.

LEUCOCYTES AND THE METHYLENE BLUE REDUCTION TEST[1]

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The observation is not infrequently made that some samples of milk apparently of low bacterial content have unexpectedly short reduction times. It has been customary to explain this phenomenon by assuming a reducing activity for milk leucocytes, although unequivocal acceptance of this explanation is not always possible in the absence of any more adequate measure of bacterial numbers than the methylene blue reduction test itself. In the present study an attempt has been made to use more delicate criteria of the influence of bacteria on the reduction times of such milks than the plate count or a cursory preliminary microscopic examination of the milk.

HISTORICAL

Skar (6) demonstrated reduction of methylene blue in sterile milk by leucocytes from the lymph gland of a steer. He believed that a leucocyte content up to approximately 6.7 million per cc. cannot reduce methylene blue in milk in the standard test but that leucocytes effect reduction of the dye if they are kept evenly distributed by periodic agitation of the milk during incubation.

Barthel (1), although recognizing the reducing power of leucocytes, is not inclined to attribute to this power great importance in milk control.

Wilson (9) concurs in the opinion that leucocytes are a factor in the reduction test but was unable to effect any marked decrease in "aerobic" reduction times of milks to which suspensions of rabbit leucocytes were added.

Ramsdell (5) observed a general but not direct relation between the reduction of resazurin and the leucocyte content of milk but was unable to demonstrate reduction of either resazurin or methylene blue by washed leucocytes. He believed "the cause of reduction must be the result of the presence of substances associated with cells, or substances present in abnormal milks in amount comparable to the cell content."

Devereux and Bryan (2) and Hastings (4) regard leucocytes as being significant in the reduction test, at least in better class milks.

METHODS

The technique of collection and analysis of the milk samples is described elsewhere (7) and will not be repeated here. Plate counts are not reported

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[1] The data contained herein are taken from a thesis presented by N. J. Strynadka (now Inspector of Dairy Products, Dairy and Cold Storage Branch, Dominion Department of Agriculture) at the University of Alberta in partial fulfilment of the requirements for the degree of Master of Science.

as they were found to contribute practically nothing to the study. The Breed counts refer to bacteria only and the number of examined fields from which they were computed is in each case cited except when the bacterial content was in the millions in which case usually 5 microscopic fields per Breed smear were counted.

The leucocyte counts are computed from the examination of 60 microscopic fields per Breed smear except when the count was very high in which case fewer fields were observed. All cells other than the cells of microorganisms were classed as leucocytes and differentiation of kinds of leucocytes was not attempted. All bacterial and leucocyte counts are on a per cc. basis and the methylene blue reduction times are reported in hours and minutes, 1 : 45 meaning 1 hour and 45 minutes.

CORRELATION BETWEEN LEUCOCYTE COUNTS AND REDUCTION TIMES

The coefficient of correlation between the leucocyte counts and the standard methylene blue reduction times of 158 samples of aseptically-drawn milk was found to be 0.698 ± 0.027. This constant as a sole criterion is not sufficiently high, in the opinion of the authors, to justify the popular assumption that milk leucocytes reduce methylene blue in milk.

THE INITIAL BREED COUNT

The initial 1000 field Breed counts are available for 95 of the 158 samples of milk and show that in the large majority sufficient bacteria were probably present to account for reduction through bacterial action irrespective of the leucocyte count which sometimes was very high. There were a few exceptional samples having leucocyte counts over 1 million, reduction times of less than 10 hours and low Breed counts. There were also 6 samples with low leucocyte and Breed counts and short reduction times. It is probable that the initial 1000 field Breed count when applied to this type of milk is not a sufficiently precise measure (7) to justify a conclusion from the foregoing data further than that in the majority of the samples the bacterial content was high enough to account for reduction of the dye independently of the leucocytes.

THE BACTERIAL CONTENT AT THE TIME OF REDUCTION

It has been shown that in samples of this class of milk about which there is no suspicion of abnormality the bacterial content at the moment of reduction is many millions per cc. as measured by the Breed count (8). It would appear sound to assume that in such samples the only practically significant reducing influence is exerted by the bacterial cells. In our present state of knowledge the number of bacteria at the time of reduction seems to be the most precise criterion of the preponderating influence of the bacteria on the reduction time.

The Breed counts at the moment of reduction were found to be over 60 million in 34 of 46 samples of aseptically-drawn milk. The reduction times of 19 of these samples were less than 10 hours but the Breed counts on reduction of 7 of these samples were over 60 million. The remaining 12 milks (tables 1 and 2) are interesting exceptions.

TABLE 1

Ten milks reacting abnormally to the reduction test

Milk number	Reduction time	Leucocyte count	Initial 2000-field Breed count	2000-field Breed count at reduction	60-field Breed count after total of 8 hours incubation
1	0:30	47,400,000	477,000	68,400	590,000
2	0:45	17,800,000	107,000*	253,800*	
3	0:55	8,300,000	142,000	86,000	670,800,000
4	1:45	4,160,000	119,700	364,200	
5	1:45	5,340,000	91,200	59,700	
6	1:45	15,960,000	48,000	43,000	6,000,000
7	2:10	7,520,000	335,000	146,000	920,000
8	3:30	4,150,000	200,700	56,400	140,000
9	5:00	680,000	39,200	81,600	210,000
10	7:15	3,500,000	56,100	435,600*	

* 1000-field count.

The initial plate counts of these 12 exceptional milks varied from 50 to 7600 per cc. but the initial Breed counts were in some cases rather high. The 2000 field Breed count at reduction was in only 1 sample over 0.5 million while the leucocyte counts were low (less than 1 million) in 2 samples.

These data are not clear-cut evidence that the leucocytes possessed a reducing power. From the point of view of numbers only it is difficult to attribute to 4 million leucocytes in one milk a reducing power of 1:45 and to 3.5 million in another a reducing power of 7:15 while it took 16 million in a third 1:45 to reduce the dye. Samples 9 and 12 were low in leucocytes and in bacterial content at reduction. When these two milks are considered with the six exceptional milks mentioned in the preceding section entitled *The Initial Breed Count* (one of which had a reduction time of 6:45, an initial 1000 field Breed count of 6000 and a leucocyte count of 180,000) the reducing power of the leucocytes is not a tempting explanation of the short reduction times.

For research purposes in this laboratory the standard methylene blue reduction test is routinely supplemented by the modified reduction test (hourly or half-hourly agitation of the tubes during incubation). Occasionally samples of aseptically-drawn milk were encountered which had considerably longer modified than standard reduction times. In each case where the particulars of the animal giving such milk was available a history

TABLE 2

Two milks reacting abnormally to the reduction test

Milk No.	Reduction time		Leucocyte count	Initial Breed count	Fields examined	Breed count at reduction	Fields examined	60-field Breed count after 8 hrs. incubation	Breed count at (modified) reduction
	Standard	Modified							
11	5:00	7:15	2,100,000	143,100	2,000	1,017,600	1,000	18,660,000	127,200,000
12	6:15	14:45	860,000	75,000	1,000	132,800	2,000	350,000	64,200,000

of udder abnormality was found. In two such milks, reported in table 2, it is evident that bacterial action was responsible for the modified but not the standard reduction times.

These results do not confirm Skar's theory that shortened reduction times in the modified test are due to the more even distribution of the leucocytes because of agitation. A few samples of aseptically-drawn milk of short standard reduction times, including samples 11 and 12, were encountered which when shaken immediately after reduction had second reduction times varying up to 10 to 12 hours. It is, indeed, difficult to accept the reducing power of the leucocytes as the explanation of these observations.

It is doubtful if the 2000 field Breed count is sufficiently accurate to justify the conclusion that phagocytosis was responsible for lower Breed counts at the time of reduction than initially in any of these milks. It is possible that bacterial reproduction was continuous in all of these milks but was not apparent because of phagocytic action of the leucocytes. Nothing was observed that caused suspicion that this phenomenon was operative and the modified reduction times of milks 11 and 12 are not in support of such a theory.

THE ADDITION OF LEUCOCYTES TO MILK

In 1913 Skar (6) reported the reduction of methylene blue in sterile milk by an added suspension of leucocytes from the lymph gland of a steer. Gay

TABLE 3

The reduction times of milk plus bovine blood leucocytes

Tube number	Description of samples	Modified reduction time	Breed count at reduction
1	Milk only	12:30	
2	" "	12:45	
3	" "	13:15	
4	9 cc. milk + 1 cc. leucocyte suspension*	11:00	200,000,000
5	9 cc. milk + 1 cc. from Tube 4	11:45	
6	9 cc. milk + 1 cc. from Tube 5	12:15	
7	9 cc. milk + 1 cc. leucocyte suspension*	10:45	190,000,000
8	9 cc. milk + 1 cc. from Tube 7	11:30	
9	9 cc. milk + 1 cc. from Tube 8	12:45	
10	9 cc. milk + 1 cc. blood serum	12:00	120,000,000
11	9 cc. milk + 1 cc. from Tube 10	12:00	
12	9 cc. milk + 1 cc. from Tube 11	12:45	
13	9 cc. milk + 1 cc. red blood cell suspension	11:00	126,000,000
14	9 cc. milk + 1 cc. from Tube 13	12:30	
15	9 cc. milk + 1 cc. from Tube 14	12:30	

* By computation this milk leucocyte suspension mixture contained approximately 50 million leucocytes per cc.

and Oram (3) demonstrated the reduction of methylene blue in sterile broth in the presence of leucocytes. The failure of the leucocytes to reduce methylene blue similarly in the presence of a streptococcus filtrate was ascribed to a leucocyte-destroying activity of "streptococcus leucocidin."

In the present study blood was drawn aseptically from the jugular vein of a Jersey cow into a flask of sterile physiological saline solution. The leucocytes were separated by repeated centrifugalization, decantation and washing in sterile saline solution until finally a clear suspension of approximately 500 million leucocytes per cc. was obtained. This suspension as well as clear serum and a suspension of the separated red blood cells was added to milk drawn aseptically from the udder of the same cow in varying proportions as outlined in table 3. The animal from which the blood and milk were drawn had not had a recognized udder abnormality while the milk had a standard reduction time of approximately 25 hours and a leucocyte count of 330,000. Only modified reduction times are reported in tables 3 and 4 because the normal variation of reduction times in replicate tubes of this milk militates against an intelligent interpretation of the standard reduction time results. It cannot be said with certainty that either the added leucocytes, red blood cells or blood serum had a measurable effect on reduction times. Whatever effect there may have been was small and was the same for red blood cells as for leucocytes. Sufficient bacteria were present at reduction to account for reduction.

Efforts to stain the leucocytes after their addition to the milk failed. It was thought that the loss of staining properties might be accompanied by loss of reducing power. In an endeavor to study the effect of adding to milk leucocytes retaining their staining properties 200 cc. of sterile physiological saline solution were injected intraperitoneally into a rabbit early in

TABLE 4

The reduction times of milk plus rabbit leucocytes

Description of samples	Modified reduction time		Leucocyte count	Breed count at reduction
	Tube			
	1	2		
45 cc. milk + 10 cc. leucocyte suspension	11:00	12:00	1,120,000*	66,400,000
45 cc. milk + 7 cc. leucocyte suspension	11:00	12:00	730,000	68,400,000
45 cc. milk + 3 cc. leucocyte suspension	11:00	11:00	590,000	77,200,000
45 cc. milk + 0.5 cc. leucocyte suspension	10:30	10:30	520,000	70,400,000
Milk only	10:00	10:30	340,000	
45 cc. milk + 10 cc. saline solution	11:00	11:00		84,000,000
45 cc. milk + 5 cc. saline solution	10:30	11:00		

* By computation this milk leucocyte suspension mixture contained 2,096,363 leucocytes per cc.

the morning followed by a further injection of 100 cc. late in the afternoon. Three hours later 200 cc. of exudate were removed by aspiration. By centrifugalization, decantation and washing in sterile saline solution a suspension containing approximately 10 million leucocytes per cc. was finally obtained. Milk from the same animal as previously used was treated immediately as outlined in table 4. It is seen that the leucocytes retained their staining properties in fair degree after their introduction into the milk but no decrease in reduction time is noticeable.

Since the completion of these experiments Wilson (9) reported reduction times of raw and pasteurized milks to which varying concentrations of rabbit leucocyte suspensions were added. Although he believes that reduction by leucocytes was demonstrated, he observes that "the results were a little irregular" and "extremely difficult to understand."

DISCUSSION AND CONCLUSIONS

The mere presence of leucocytes in milk, even in large numbers, and the absence of bacteria in large numbers do not prove a reducing power for the leucocytes. The attempts to furnish proof of such a reducing power have to date depended on strictly quantitative measurements and in the opinion of the writers have been unsuccessful. The need for qualitative measurements seems apparent.

The observations reported in the literature and in this paper are explicable in terms consistent with accepted theories of dye reduction in milk. There are reasons for believing that the abnormal udder conditions responsible for milk of high leucocyte content are also responsible for abnormally high concentrations of reducing substances in the milk. The presence of reducing substances in abnormally high concentrations would explain the observations under discussion without soliciting aid from the leucocytes. This is not, of course, a denial of the possibility of some leucocytes possessing reducing properties but the bulk of the evidence is that leucocytes are rarely, if ever, the main or significant influence in the reduction of methylene blue in milk in practice.

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REFERENCES

(1) Barthel, C. 1917. Quoted from O. Skar (1931).

(2) Devereux, E. D. and Bryan, C. S. The effect of streptococcic mastitis on the methylene blue reduction test. The Milk Sanitarian. 6: 9, 1937.

(3) GAY, F. P. AND ORAM, FLORENCE. Streptococcus leucocidin. J. Imm. 25: 501, 1933.

(4) HASTINGS, E. G. Limitations of the methylene blue test in grading milk. The Milk Dealer, 25: 72, 1935.

———. Wis. Agr. Station Bul. 435: 85, 1936.

(5) RAMSDELL, G. A. The resazurin test for the sanitary condition of milk. Proc. 14 Ann. Conv. N. Y. State Ass. Dairy and Milk Insp., 57, 1936.

(6) SKAR, O. Verhalten der Leukozyten der Milch bei der Methylenblaureduktaseprobe. Zeitsch. f. Fleisch u. Milchhyg. 23: 442, 1913.

———. Die Reduktaseprobe. Rep. Int. Dairy Congress, Copenhagen. German ed. Sec. 2, 58, 1931.

(7) STRYNADKA, N. J. AND THORNTON, H. R. The accuracy of the direct microscopic (Breed) count of bacteria and leucocytes in milk. JOUR. DAIRY SCI. 20: 685, 1937.

(8) STRYNADKA, N. J. The methylene blue reduction test. Thesis, University of Alberta Library. 1935.

(9) WILSON, G. S. The bacteriological grading of milk. Medical Research Council, Special Rep. Series, No. 206, 245, 1935.

THE VISCOSITY OF ICE CREAM MIX MADE WITH PLAIN AND SUPERHEATED CONDENSED SKIM MILK

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Ice cream manufacturers at one time were convinced that good ice cream mix should be viscous. Processing mix in homogenizers was not a common practice at that time and it is not unlikely that a viscous mix was desirable under the freezing, storage, and handling conditions which prevailed. With the wider use of the homogenizer, better freezers and better methods of distribution, it was later demonstrated that high viscosity was of no special value and in recent years the trend has been towards mixes of low viscosity.

Various methods of increasing the viscosity of mix were employed at the time viscous mixes were deemed desirable, among them being the use of superheated condensed products. Superheated condensed milk is not widely used at the present time, probably because of its influence on the viscosity of the mix, difficulties in handling it, and its slight "cooked" flavor. However, some manufacturers find its use desirable, as it produces a type of ice cream which is popular in some localities.

Relatively little has been written on the use of superheated condensed milk in ice cream. Tracy (1) found an improvement in texture and body of the ice cream and its resistance to melting when superheated solids were used. He also noted an increase in the mix viscosity. Williams and Hall (2), using a sales-preference test as a means of determining desirable types of ice cream, found that the use of superheated condensed skim milk produced a better ice cream than plain condensed. Johnson and Ward (3) have shown that the viscosity of superheated condensed milk is not a true index of the value of milk for bread making, but observed that it is superior to condensed milk which has not been superheated. They state that it is the heat treatment accorded the milk which operates to improve the baking quality of the milk, and this may or may not be reflected in the viscosity of the product.

In the manufacture of superheated condensed milk, the temperature is raised to 185–195° F., by injecting live steam into the product before removing it from the vacuum pan. This treatment causes a thickening of the product, the degree of thickening depending on the time and temperature of heating. The heating is discontinued at the point of maximum thickening as any overheating results in a coarse coagulation of the product. Over cautious and inexperienced operators usually stop heat-

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ing before the point of maximum thickening, and thus the benefits of properly superheated milk are only partially obtained. Since superheating, when properly conducted, brings about a marked increase in viscosity, it is to be expected that the beneficial effects of superheating are often attributed to the increase of viscosity and this property is frequently used as a measure of its value for ice cream.

The viscosity of ice cream mix and its influence on the freezing properties and quality of the finished ice cream has been studied by a number of investigators. Leighton and Williams (4) first showed that ice cream mix had an "apparent" viscosity after proper aging and that agitation, such as is given the mix in the freezer, reduced this to a lower value which they termed "basic" viscosity. Following the work of these authors, most investigators used the term "basic" viscosity as that which results when the mix is strongly agitated as in the freezer or with special devices designed for this purpose (6), although Hening (5) recommends homogenization of aged mix as a means of obtaining the "basic" viscosity. It is probable that the action of the homogenizer is more drastic than the dashers of a freezer and, therefore, the method of Hening may give viscosity values below those which are of actual interest in the manufacture of ice cream.

During the course of some investigational work on superheated condensed skim milk, it was observed that the viscosity could be markedly reduced by homogenization. The terms "apparent" and "basic" viscosity, suggested by Leighton and Williams (4) for ice cream, were used to describe the viscosity of this product before and after homogenization.

It is the purpose of this paper to record the observations made during a study of the effect on ice cream of using superheated condensed skim milk which had been reduced by homogenization to its basic viscosity in comparison with plain condensed skim milk and with superheated which had not been treated to reduce its viscosity.

EXPERIMENTAL

Determination of viscosity: In this work the viscosity of the various products was determined by means of a Saybolt viscosimeter having an orifice of 0.082″ diameter. The time required for 60 cc. of the product to run through at the designated temperature was taken as the viscosity. The Saybolt tube was mounted in a water bath to insure accurate temperature control. All samples were aged over night at 40°F. before viscosity determinations were made.

Preparation of the condensed products: Plain condensed skim milk and superheated condensed skim produced in a commercial plant were used throughout this experimental work. In preparing the homogenized superheated product, the material was passed through a single stage homogenizer

at a temperature of 125° and at pressure of 3000 lbs. per sq. in. and held a day at 40° before being used in the mixes.

Preparation of the mixes: All of the mixes made in this experiment were of the following composition:

Butterfat	13%
Milk solids not fat	11%
Sugar	15%

All of the milk solids not fat not supplied by the whole milk (4% fat) and cream (40% fat) were obtained from the condensed product under consideration. In those mixes made with gelatin, a gelatin of 160 Bloom was used in the amount of 0.4%. The mixes were compounded in the usual manner, pasteurized at 150° F. for 30 minutes, and homogenized in a two stage homogenizer using 2000 lbs. on the first valve and 1000 lbs. per sq. in. on the second valve, which gave a total of 3000 lbs. per sq. in. The mixes were cooled to 40°F. and aged over night.

Since the primary purpose of this study was to observe the influence of the viscosity of the condensed product on the viscosity of the mix, not all of the mixes were frozen into ice cream. However, a few of the mixes were frozen and for this a 40 qt. batch freezer was employed, the ice cream being drawn at 90% overrun. A record was made of the time required to reach this overrun and also of the general quality of the finished product after three days in the hardening room.

RESULTS AND DISCUSSIONS

Viscosity of the condensed products: Typical data on the viscosity of the condensed products and the resulting mixes are summarized in Table 1. It will be seen that when superheated condensed skim was homogenized a marked reduction in viscosity was obtained. Under the conditions of this experiment the viscosity of the homogenized superheated product was greater than that of the plain condensed but the difference, although noticeable, was small in comparison with the difference between the plain and the unhomogenized superheated. The superheated condensed which had been homogenized was of such viscosity that it could be handled easily, pouring readily and draining rapidly from cans.

Viscosity of mixes made without gelatin: Inspection of the data in Table 1 indicates that in those mixes made without gelatin there was practically no noticeable difference between the viscosity of the three mixes. The high apparent viscosity of the superheated condensed does not carry over into the mix, showing that the homogenization process given the mix is effective in reducing the viscosity of the mix to its basic viscosity. The small difference noted in both the apparent and basic viscosity between the one mix containing plain condensed skim milk and

the two mixes, made with superheated condensed, was due to the heat treatment these two products received, but since there was practically no difference between the mixes containing the homogenized and unhomogenized condensed, it may be said that the beneficial effects of superheating cannot be accurately measured by its viscosity.

TABLE 1

The viscosities of plain, superheated and homogenized superheated condensed skim milk and ice cream mixes made with these products

Kind of product	Total solids of product %	Viscosity of product at 50° F. Secs.	Viscosity at 40° of ice cream mix made with each source of M.S.N.F.			
			No gelatin used in mix		0.4% gelatin used in mix	
			Apparent viscosity Secs.	Basic viscosity* Secs.	Apparent viscosity Secs.	Basic viscosity* Secs.
Plain condensed skim milk	28.7	54	54	52	508	201
Superheated condensed skim milk	28.4	more than 36,000	69	67	about 1000	331
Homogenized superheated condensed skim milk	28.4	446	68	67	about 1000	336

* Mixes reduced to basic viscosity by means of a laboratory agitator in absence of air (6).

Viscosity of mixes made with gelatin: An amount of gelatin (0.4%) was used in these mixes to make a definite gel. From the data presented in Table 1 it will be seen that the presence of the gelatin increased the viscosity of the mix. The influence was chiefly on the apparent viscosity, which was comparatively high. However, the gelatin also increased the basic viscosity to a noticeable degree. The same essential differences in apparent and basic viscosity existed between the three mixes as was found in the mixes made without gelatin.

Freezing properties of the mix and quality of the ice cream: Very little difference in freezing time was noted in the few mixes which were frozen and the differences were not considered of commercial importance. It may be said, however, that in every case mixes made with plain condensed skim milk whipped very slightly faster than the other two mixes in the series.

In comparing the general quality of the three ice creams made in this series, it may be said that the ice cream made with the plain condensed skim was somewhat less smooth in texture and slightly weaker in body

than the two ice creams containing the superheated condensed products. This sample also differed from the other two in that it had a slightly less cooked flavor. As there was no difference in the texture, body and flavor between the ice cream made with the superheated condensed and the homogenized superheated condensed, it is evident that the homogenization of the condensed product had no effect on its value for ice cream as far as quality of the ice cream was concerned.

SUMMARY

Mix made with superheated condensed skim milk is but slightly more viscous than mix made with plain condensed skim milk.

The high apparent viscosity of superheated condensed skim milk can be reduced by homogenization to such an extent that the product may be easily poured and handled.

Reduction of the viscosity of superheated condensed by homogenization in no way influences the viscosity of ice cream mix.

The viscosity of superheated condensed is not a true measure of its value in ice cream mix.

Whatever beneficial effects are obtained by using superheated condensed skim milk, they are not the result of the higher viscosity, but are probably due to the high heat treatment accorded the product.

REFERENCES

(1) Tracy, P. H. A study of the use of superheated and unsuperheated plain condensed bulk skim milk in the manufacture of ice cream. Jour. Dairy Sci. 6: 205. 1923.

(2) Williams, O. E., and Hall, S. A. Effect of heat treatment upon the quality of dry skim milk and condensed skim milk for ice cream. U. S. Dept. Agric. Cir. 179. 1931.

(3) Johnson, A. H., and Ward, F. C. The relation between the viscosity of nonsweetened condensed skim milk and baking quality. Cereal Chem. 13: 550. 1936.

(4) Leighton, Allan, and Williams, O. E. The basic viscosity of ice cream mixes. Jour. Phys. Chem. 31: 596. 1927.

(5) Hening, J. C. Some observations on the basic viscosity of ice cream mixes. Jour. Dairy Sci. 14: 84. 1931.

(6) Whitaker, R. A device for reducing an ice cream mix to its basic viscosity. Jour. Dairy Sci. 12: 285. 1929.

THERMAL SHOCK RESISTANCE OF MILK BOTTLES

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The presence of significant numbers of thermal shock cracked bottles in the daily rejects of two large dairies was reported in a previous study (1). The present study was made in order to better understand the relation of thermal shock resistance of bottles determined by test to their failure in actual usage.

The thermal shock test for milk bottles was first introduced into the dairy industry in this country by Kouwenhoven (2) in 1926. The routine usage of a thermal shock test in the Chicago milk bottle exchange was reported in 1934 (3). Private concerns have used some form of the test for a number of years. The origin of the test in the glass business is probably lost in the antiquity of the art. Some effort has been made in recent years to study the limitations of the test and to standardize a method. It was announced in the spring of 1937 that the Glass Container Association had authorized a research project to develop standard bottle tests including the thermal shock test.

Although there appears to be some disagreement among glass technologists as to whether or not the thermal shock test is a general test for the strength of bottles, it is well agreed that much can be learned through its use about their thermal endurance in commercial usage. Inasmuch as the resistance of glass to compression is much greater than its resistance to tension, it is believed that tensile stresses are chiefly responsible for thermal, as well as impact breakage (4). The thermal shock test made by rapidly cooling hot bottles over various temperature ranges, applies a controlled trial tension to the bottle.

The thermal shock test used in this study was developed after much preliminary experimentation and was found to give reproducible results on representative samples of commercial bottles. The test is naturally somewhat empirical and is subject to human errors. All the tests reported here were made by one person who exercised all possible care.

THE THERMAL SHOCK TEST

Thermal shock tests were made in two square galvanized iron sinks approximately 36 inches long, 24 inches wide, and 24 inches deep. One was heated directly by gas flame and the other was kept cold by a small stream of cold water. The hot tank was equipped with a mechanical agitator and the cold tank was equipped with a constant level drain. The temperatures

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were controlled to within 1°F. of the desired temperature. The hot tank had a false bottom of wood slats to prevent the bottles from resting on the heated metal surface. The depth of the water in each tank was regulated so that the bottles in an upright position were covered by 1½ to 2 inches of water. The bottles to be tested were placed individually, using tongs, in the hot tank, allowed to fill slowly to warm, then emptied and submerged again. All the bottles were thus placed in the hot water at intervals of one minute. After 10 minutes or longer had elapsed, starting with the first and continuing in order at one minute intervals, the bottles were lifted out, inverted to empty, and plunged vertically bottom downward to the bottom of the cold water tank as rapidly as possible allowing them to fill under water. This operation required less than 5 seconds. As soon as all the bottles had been shocked they were carefully examined individually for cracks. Many of the cracks found were very fine and not very deep in the surface of the glass. Direct sunlight was more satisfactory than diffuse sunlight or incandescent-lamp light for the examinations. It was found that if the shocked bottles remained too long in the cold water or air after shocking the fine cracks closed and became invisible. The examinations were made, therefore, as soon as possible after the shocking.

TABLE 1

The effect of thermal differential on the resistance of quart bottles to thermal shock

Hot tank °F.	Cold tank °F.	Diff. °F.	No. of bottles tested	Cracked		Location of cracks
				No.	%	
			Lot A			
124	44	80	102	1	1.0	1—Lip
129	44	85	132	2	1.5	2—Lip and neck
134	44	90	40	3	7.5	3—Lip and neck
138	43	95	30	7	23.0	5—Lip and neck 1—Shoulder 1—Bottom
145	45	100	20	6	30.0	4—Lip and neck 2—Bottom rim
147	42	105	19	9	47.0	6—Lip, neck, sides & bottom 2—Lip and neck 1—Bottom
			Lot B			
126	66	60	47	1	2.1	1—Lip
120	50	70	25	3	12.0	3—Lip and neck
130	50	80	20	4	20.0	4—Lip and neck
140	50	90	15	8	53.0	6—Lip and neck 2—Bottom rim and sides

I. RELATION OF TEMPERATURE DIFFERENCE TO CRACKING

Two gross of new quart bottles of one make (Lot A) were carefully examined individually and the few damaged and flawed bottles found were discarded. Previous work had shown that the presence of surface defects reduces the normal resistance to shock. After thoroughly mixing the lot of bottles, sample portions were tested at thermal differentials varying from 80°F. to 105°F. in steps of 5°F. The results are shown in Table 1. The relation between thermal differential and percent of bottles cracked in this experiment is shown graphically in Fig. 1.

Another lot of bottles of the same make, but manufactured at a later date (Lot B), were tested in a similar manner. They were sampled from 7 gross of new bottles used in the bottle washer thermal shock experiments which will be described in Part III. Since they were found to be consider-

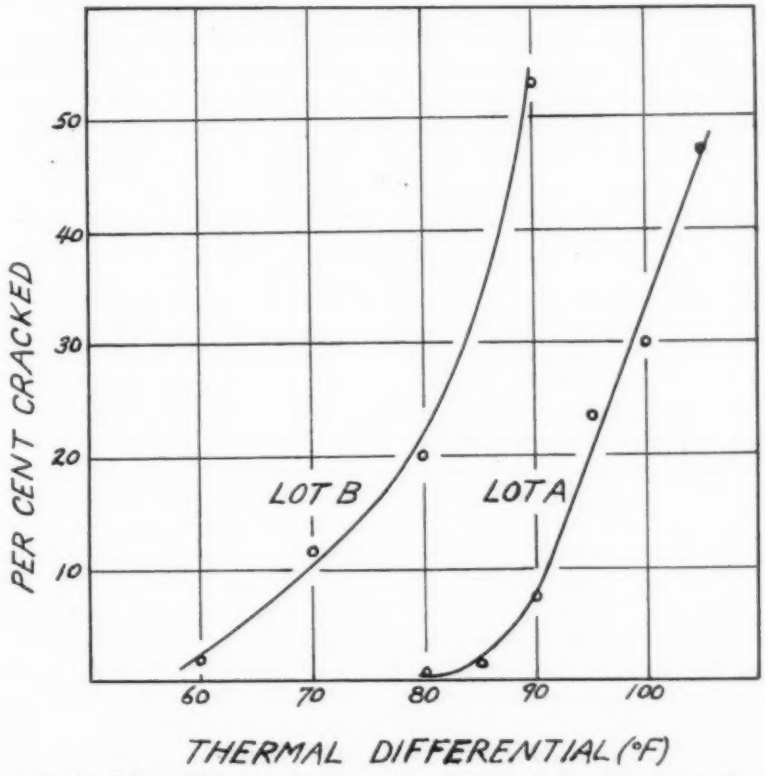

FIG. 1. Relation between thermal differential and per cent of cracked quart bottles in the thermal shock test.

ably less resistant to thermal shock than the first lot tested, the thermal differentials used were from 60°F. to 90°F. in steps of 10°F. The results are shown in Table 1. The relation between thermal differential and percent of bottles cracked is shown graphically in Fig. 1.

In each curve there is a leveling off below 10% cracked, indicating that there is a small percentage of bottles very low in thermal shock resistance. It should be pointed out that a range of bottle breakage as low as 0.1% to 1.0% is of economic importance in commercial milk plant operation. The cracks in these bottles were in the outer surface of the glass. In general, the cracks at low thermal differentials were shorter and more difficult to see than those at the higher differentials. These short fine cracks have been observed in newly washed bottles in commercial operations by individual inspection. The inspectors at the washer discharge almost invariably fail to see them. It will be noted that cracks did not develop in the bottom or side regions of the bottles except at greatest thermal differentials. This is contrary to the results obtained by Murgatroyd (5) who found that bottles cracked in the thermal shock test only in the wall near the base (bottom rim). In the test he used, the cold bottles standing in cold water up to the lip were filled with hot water. It is questionable whether the lip region is shocked as severely, by this method, as is the lower region. Considering the average cracking temperature or the temperature at which 50% were cracked, Lot A had a 15°F. favorable margin over Lot B.

II. EFFECT OF REPEATED THERMAL SHOCKS

A representative sample, consisting of 30 bottles, of a shipment of new quarts were tested at a differential of 90°F. (140° to 50°). The whole test was repeated a total of 20 times examining the bottles between each test and noting the effects of each shock. The results are recorded in Table 2.

The twenty bottles from Lot B, tested at 80°F. differential in Part I, were retested at 80°F. differential for 9 more consecutive times with examination between as previously described. The results are shown in Table 3.

It appears that repeated shocking resulted in continued breakage up to a limit which differed for the two lots tested. Murgatroyd (5) reported a similar effect of repeated shocking and attributed it to the inaccuracy of the test. It would appear that this effect is related to the inherent nature or weakness of the bottles and may be a type of fatigue influenced by the time element or the number of shocks. The cracks in most of the bottles were associated with the tiny impact marks which result when bottles strike together. There were impact marks, however, on the bottles which survived the shocking. This seems to indicate that the impact marks help determine the location or path of the cracks. Cracks in the bottoms and bottom rims of the bottles did not appear until the bottles were shocked a number of times. This region was also more resistant in the temperature differential tests.

TABLE 2

Thermal shock cracking of new quart bottles (Lot A) during 20 successive shocks at 90° F. differential

Bottle No.	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	N	–	–	–	–	–	–	R	–	R, X	R, X, D						
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	L	–	–	–	–	–	–	X	–	–	–	–
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	L	–	–	–	–	R	–	–	D										
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	L	–	–	–	–	–	–	–	–	–	–
9	0	0	L	X	–	–	X	–	–	–	X	–	–	–	–	R	R, X	–	–	R, X, D
10	0	0	0	0	0	0	0	0	L	–	X	–	X, D							
11	0	N	X	–	–	X	–	–	D											
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	L	–	X, D			
14	0	0	0	0	0	0	0	0	0	B	–	–	R	R, X	–	–	–	–	X, D	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	L	X	–	–	–	–	–
16	0	0	0	0	0	0	0	0	0	0	0	0	0	R	–	–	–	–	–	–
17	0	0	0	0	0	L	–	–	–	–	X	–	–	–	X, D					
18	0	0	0	L	–	–	–	–	–	–	–	–	–	–	–	–	R	R, X	–	R, X
19	L	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	X, D			
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	L	–	–	–	–
21	0	0	0	0	0	0	0	0	0	0	0	L	–	–	–	–	–	–	–	R
22	0	0	0	0	0	0	0	0	L	–	–	R	–	R, X	–	–	R, X, D			
23	0	0	0	0	0	0	0	R	–	X	X	X	X, D							
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R	X	–	–
25	0	0	0	0	0	0	R	X	–	–	–	–	–	–	–	–	–	–	–	X
26	0	0	0	0	0	0	0	0	0	0	0	L	X	X	–	–	–	X	–	–
27	0	0	0	0	0	0	0	0	L	X	–	–	–	X	–	–	–	–	–	R
28	0	0	0	0	0	S	–	X	–	X	D									
29	0	0	0	0	0	0	0	0	0	0	0	0	L	X	X	X	–	–	–	X
30	0	0	0	0	0	0	0	0	0	0	0	0	L	X	–	–	–	–	R	R, X
Total Cracked-Cumulative	1	3	4	6	6	8	9	10	14	16	16	18	20	22	23	24	25	25	25	25

Key to symbols:

L = Crack in lip.
N = Crack in neck.
S = Crack in side.
R = Crack in bottom rim.
B = Crack in bottom.

0 = No cracks.
X = Crack extended.
– = No change.
D = Discarded bottle.

TABLE 3

Thermal shock cracking of new quart bottles (Lot B) during ten successive shocks at 80° F. differential

Bottle No.	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	L, N	X	D							
6	L	L, X, N	–	–	–	X	–	R, D		
7	0	0	0	0	0	R	–	–	–	–
8	0	L	N	X	–	X	X	–	–	–
9	L, N	–	X	R, D						
10	0	0	L	–	–	–	–	–	R, D	
11	0	0	0	0	L	–	–	–	–	–
12	0	0	0	0	0	0	0	0	0	0
13	0	L	X	X	–	–	–	–	S, D	
14	0	L, N	X	R	D					
15	0	L, S	D							
16	0	0	0	0	0	0	L	–	–	–
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	L	X	X	–	–	–
19	0	0	0	0	0	0	0	0	0	0
20	L	–	–	–	–	–	–	–	–	–
Total Cracked-Cumulative	4	8	9	9	11	12	13	13	13	13

Key to symbols:

L = Crack in lip.
N = Crack in neck.
S = Crack in side.
R = Crack in bottom rim.
B = Crack in bottom.
0 = No cracks.
X = Crack extended.
– = No change.
D = Discarded bottle.

III. THERMAL SHOCK CRACKING OF BOTTLES DURING WASHING

A plant experiment was made in which approximately seven gross of new quart bottles of one make were washed in a triple tank, 16 pocket-wide Meyer-Dumore washer, on each of 15 consecutive days. After the first time through, the whole lot was sampled at the discharge end by removing 2 bottles from every row of 16. These were thermal shock tested in the laboratory for comparison and are discussed under Part I (Lot B). The remainder of the bottles, numbering 868, were allowed to run to the fillers where they were loaded into new wood-post cases and subsequently moved by conveyors and 4 wheel trucks to the loading end of the washer. There

TABLE 4

Data on washer experiment

Washing No.	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	Avg.
Temp. (°F.) of:																
Prerinse	83	83	87	83	88	90	83	83	79	93	81	78	95	95	82	85.5
Tank No. 1	117	118	118	117	114	116	121	115	115	114	113	119	119	124	116	117.1
Tank No. 2	147	148	144	144	136	145	148	133	135	139	139	147	134	145	153	142.4
Tank No. 3	135	127	124	124	130	127	127	125	118	126	122	138	121	127	129	126.6
Outside brush spray	90	82	82	96	85	80	79	95	98	101	98	95	96	79	98	90.2
Inside spray	91	91	83	77	87	87	86	96	81	90	88	85	81	92	83	86.5
Inside brush spray	91	91	83	77	87	87	86	96	81	90	88	85	81	92	83	86.5
City water spray	60	60	60	60	61	61	61	62	62	63	63	62	62	62	64	61.6
Chlorine water spray	63	63	63	63	64	64	64	65	65	65	65	65	65	65	67	64.6
Stops during washing in minutes	0	0	12	0	3	0	0	0	0	6	0	2	0	0	0	
Thermal cracks—																
Cumulative per cent	1.3	1.8	2.5	2.5	2.9	2.9	3.0	3.1	3.1	3.5	3.5	3.7	3.8	3.9	3.9	

they were individually examined under a 150 watt daylight lamp and all thermal and impact damages were noted. This individual examination was made after each washing. During the washings, temperatures were taken with accurate thermometers at the washer and all stops were noted. When the thermal shock cracks were very fine or just starting they were allowed to remain in the test in order to observe the further development of the cracks. Those with large cracks and impact shock defects were removed after each examination. Account was taken of these in the calculation of the cumulative percentage cracked by thermal shock.

The pertinent data collected in this experiment are shown in Table 4 in comparison with the cumulative percentage of bottles cracked by thermal shock. A good correlation was found between the stopping of the machine and thermal shock cracking. A satisfactory explanation of this relation has not yet been found, but its importance must be stressed. The thermal differential of the various shocks encountered by the bottles during the washing experiment are shown in Table 5. The greatest thermal

TABLE 5

Thermal differentials of shocks in washer during experiment

Location of shocks	Thermal differential in °F.		
	Maximum	Minimum	Average
Prerinse to Tank No. 1	+41	+21	+21.6
Tank No. 1 to Tank No. 2	+37	+21	+25.3
Tank No. 2 to Tank No. 3	−24	− 6	−15.8
Tank No. 3 to outside brush	−48	−20	−36.4
Outside brush jet to inside jet	−19	+ 1	− 3.7
Inside jet to inside brush jet	0	0	0.0
Inside brush jet to city water jet	−34	−17	−24.9
City water jet to chlorine water jet	+ 3	+ 3	+ 3.0

Note: Prerinse jet sprays inside of bottle; Tanks No. 1, 2, and 3 submerge bottles; city water jet sprays inside; and chlorine water jet sprays inside.

differential occurred at the outside brush spray. In the washings where cracking was greatest this differential was around 42°F. to 45°F.; although in one washing with high crackage (10th), this differential was only 25°F. At the outside brushes the bottles are pushed up between two rotating fiber brushes which are being continually sprayed with water at the indicated temperature. This is an outside-surface shock as contrasted to the double surface shocks in the laboratory tests. Preliminary tests in the laboratory have shown that when bottles are tested with the shock on the outside, *i.e.*, hot empty bottles immersed in cold water just up to the lip, a 10°F. lower differential has about the same effect as when the same bottles are tested by the double-surface shock. The failure of this type of test, however, to accurately shock the lip region has already been suggested.

SUMMARY

1. The use of thermal shock tests is discussed and a suitable test for milk bottles is described.

2. The percentage of bottles cracked (up to 50%) as a function of the thermal differential was determined on two lots of bottles.

3. Repeated thermal shocking of bottles at a given temperature differential in laboratory tests, and repeated washings of bottles from the same lot in a commercial washer, both resulted in continual cracking with successive shocks.

4. Washings during which the machine stopped, resulted in more thermal shock cracking than washings during which the machine ran continuously.

REFERENCES

(1) ROLAND, C. T., AND TREBLER, H. A. A Plant Study of Damaged and Defective Milk Bottles. JOUR. DAIRY SCI. 21: 275. 1938.
(2) KOUWENHOVEN, F. W. Testing of Milk Bottles. Glass Industry 7: 137. 1926.
(3) ANONYMOUS. Dairies Adapt Bottle Tests. Glass Industry 15: 53–5. 1934.
(4) ANONYMOUS. Permanent Tensile Stresses in Glass. Glass Industry 18: 44–4. 1937
(5) MURGATROYD, J. B. Testing of Commercial Glassware. Jour. Soc. Glass Tech. 16: 5–17. 1932.

NUTRIENTS FOR LACTATION, WORKING MAINTENANCE, AND GAIN IN LIVE WEIGHT IN AMERICAN DAIRY COWS

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This note supplements a previous paper (1) concerned with the evaluation of the working maintenance exponent, c, in the equation, $DN'' = bW^c$, notation[1] as before. A different method of mathematical analysis is applied to the same experimental data, as follows.

METHOD OF ANALYSIS, ALL DATA

Distinction is made, as before, according to sign of ΔW, that is, whether the cow gained ($+\Delta W$) or lost ($-\Delta W$) in live weight, on the average, during the experimental period. The records are arranged in increasing order by W, and divided into groups by successive 10's. Each group of records so formed is fitted with the equation,

$$DN = aFCM + K + d\Delta W \quad \ldots\ldots (1)$$

by use of the normal equations:

$$(n)K + (\Sigma FCM)a + (\Sigma \Delta W)d = \Sigma DN.$$
$$(\Sigma FCM)K + (\Sigma FCM^2)a + (\Sigma FCM\Delta W)d = \Sigma FCMDN.$$
$$(\Sigma \Delta W)K + (\Sigma FCM\Delta W)a + [\Sigma(\Delta W)^2]d = \Sigma \Delta WDN.$$

Each K is taken to represent DN'', or bW^c, for its group, and W is taken to be the average live weight shown by the 10 records of its group. The K's and W's thus derived are fitted with the equation, $K = bW^c$, by use of the weighted[2] normal equations:

$$(\Sigma K^2)\log b + (\Sigma K^2 \log W)c = \Sigma K^2 \log K.$$
$$(\Sigma K^2 \log W)\log b + [\Sigma K^2 (\log W)^2]c = \Sigma K^2 \log W \log K.$$

Finally, for a given set of K's and W's, a is taken to be the average of the a's in that set; and similarly for d. We thus arrive at a solution of the equation,

$$DN = aFCM + bW^c + d\Delta W \quad \ldots\ldots (2).$$

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[1] Symbols are used to apply to each experimental period for each cow, as follows:

DN = digestible nutrients intake, pounds per day
DN′ = digestible nutrients apportioned to lactation, pounds
DN″ = digestible nutrients apportioned to maintenance, pounds per day
DN″′ = digestible nutrients apportioned to gain in weight, pounds
FCM = milk-energy yield, pounds of 4 per cent milk per day
W = average live weight, pounds
ΔW = average gain in live weight, pounds per day
n = number of cows or records
D = observed DN − calculated DN.

[2] Dr. W. Edwards Deming, U. S. Department of Agriculture, has very kindly called my attention to the necessity of weighting the normal equations by K^2. Neither the weighted nor unweighted normal equations give a true least-squares fit for $K = bW^c$ when the observed K's are so highly irregular as they are in the present data.

In equation (2), a is the pounds of digestible nutrients per pound of FCM apportioned to lactation; b is the pounds of digestible nutrients per day per pound of live weight raised to the power, c, apportioned to working maintenance; and d is the pounds of digestible nutrients per pounds of gain in live weight, apportioned to gain in live weight. Or, in symbols, $DN' = aFCM$, $DN'' = bW^c$, $DN''' = d\Delta W$, and $DN = DN' + DN'' + DN'''$.

A positive d means that the method apportions a consumption of nutrients for gain in live weight or a release of nutrients for loss in live weight. A negative d means a consumption of nutrients for loss in weight and a release of nutrients for gain in weight. While a negative d is opposed to logical expectation, it is not at all contrary to a mathematical balancing of the values to which equation (1) is fitted, because of normal irregularities and errors in the observations.

TABLE 1

Digestible nutrients apportioned to lactation, working maintenance, and live-weight gain
Records of Guernsey, Holstein and Jersey cows from various experiment station sources, in groups of 10.
(See footnote, page 585, for explanation of symbols.)

Group No.	Sign of ΔW	n	Live-weight Limits, lbs.	W	$DN' = aFCM$ a	$DN'' = bW$ 1000 b	$DN''' = d\Delta W$ d
1	−	10	634– 783	732	.2385	10.57	1.82
2	+	10	735– 790	770	.2732	9.77	1.63
3	−	10	792– 824	808	.3003	7.94	2.30
4	+	10	793– 843	819	.4256	4.64	12.38
5	−	10	833– 858	846	.2836	8.73	1.84
6	+	10	846– 885	864	.1507	13.99	−.30
7	−	11	859– 898	878	.3089	9.01	6.70
8	+	10	887– 925	906	.2812	8.30	3.58
9	−	10	902– 978	928	.2277	11.26	.28
10	+	10	929– 996	970	.3219	8.99	1.35
11	+	10	1008–1072	1046	.3172	7.87	2.80
12	+	10	1073–1120	1096	.2927	9.02	1.53
13	−	10	985–1195	1105	.3031	8.27	−2.65
14	+	10	1128–1172	1152	.2519	10.58	−1.15
15	+	12	1175–1203	1188	.3290	8.06	.10
16	+	10	1207–1232	1220	.3170	7.32	1.34
17	−	10	1203–1273	1242	.4083	4.74	−2.88
18	+	10	1239–1267	1251	.2702	8.59	2.76
19	+	10	1271–1287	1278	.2434	9.22	1.37
20	+	10	1288–1301	1296	.0906	13.34	.79
21	+	10	1305–1323	1314	.3185	6.86	1.83
22	+	10	1327–1341	1335	.2776	7.80	3.33
23	+	10	1341–1382	1363	.1846	10.04	.71
24	−	10	1331–1500	1395	.2712	8.27	1.82
25	+	10	1384–1453	1402	.1815	10.72	−2.50

Results, All Data

The $172 + \Delta W$ records give, $DN = .266FCM + .0134W^{.96} + 1.86\Delta W$.
The $81 - \Delta W$ records give, $DN = .293FCM + .1976W^{.55} + 1.15\Delta W$.
Both groups together give, $DN = .275FCM + .0161W^{.93} + 1.63\Delta W$.

The equation for both groups together is derived from the data of Table 1, in which the figures in the DN″ column are equal to 1000K of equation (1) divided by W of Table 1. That is, the $+\Delta W$ and $-\Delta W$ groups are allowed to keep their identity, rather than to mix $+\Delta W$ and $-\Delta W$ records in the same group. This may or may not be necessary. It is done with the thought that it may give more representative values to the K's of equations (1).

If the above result for both groups is taken as a summary of the 253 records, it appears that working maintenance is proportional to the .93 power of live weight. What does this mean from the standpoint of a practical feeding standard for cows in milk? The DN″ column of Table 1 gives, as indicated, the nutrients for working maintenance, K of equation (1), per day per 1000 pounds live weight, for each of the 25 groups of 10 records. In Figure 1 working maintenance per 1000 pounds live weight is plotted against live weight. The correlation between the two is $r = -.07 \pm .15$. The regression equation is $1000DN''/W = 9.67 - (.0007 \pm .0014)W$.

As thus determined, working maintenance per unit live weight is quite variable, as may be seen in Figure 1. There is a tendency for it to decrease

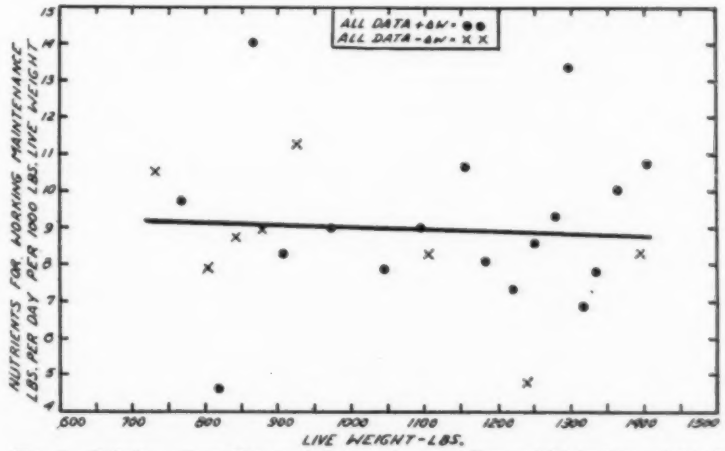

FIG. 1. Relation of working maintenance per unit live weight to live weight, from Table 1.

with live weight, but this tendency is not statistically or practically significant.

Minnesota and Cornell Data

The present method of analysis requires a considerable number of records to be justifiable. It is permissible, however, to apply it to the Minnesota data (n = 98) and to the Cornell data (n = 103). The same general plan is followed, using groups of successive 5's. Tables 2 and 3 give the results for the groups of 5. In Figure 2 working maintenance per 1000 pounds live

TABLE 2

Digestible nutrients apportioned to lactation, working maintenance and live-weight gain
Records of Guernsey, Holstein and Jersey cows from Minnesota Experiment Station, in groups of 5.
(See footnote, page 585, for explanation of symbols.)

Group No.	Sign of ΔW	n	Live-weight Limits, lbs.	W	$DN' = aFCM$ a	$DN'' = bW$ 1000 b	$DN''' = d\Delta W$ d
1	−	5	634– 735	698	.1910	10.87	−8.13
2	+	4	735– 765	753	.3452	8.27	2.94
3	−	5	752– 783	765	.3490	7.59	4.17
4	+	5	766– 789	780	.4353	6.25	−10.15
5	−	5	792– 809	800	.2163	9.15	−1.64
6	−	10*	811– 884	827	.3361	7.11	3.39
7	+	15*	790– 887	840	.0544	16.76	−4.31
8	−	5	845– 858	853	.3640	6.82	1.12
9	−	5	859– 877	869	.5267	2.89	10.82
10	−	5	887– 898	890	.3266	9.46	8.75
11	−	5	902– 923	912	.2897	8.83	1.07
12	+	5	890– 976	933	.2840	8.44	12.71
13	−	5	925– 978	944	.2578	9.56	−10.94
14	+	5	978–1071	1024	.5004	6.35	−14.96
15	−	5	985–1273	1073	.3109	8.20	.61
16	+	9*	1072–1315	1177	.1999	11.53	−2.04

* These combinations were made to get rid of negative values of b, appearing in the groups of 5.

weight is plotted against live weight for the Minnesota and Cornell data separately.

The correlations between working maintenance per unit live weight and live weight are, Minnesota, $r = .06 \pm .17$, and Cornell, $r = .03 \pm .15$. The regression equations are, Minnesota, $1000DN''/W = 7.38 + (.0014 \pm .0042)W$, and, Cornell, $1000\ DN''/W = 7.95 + (.0009 \pm .0043)W$. Both the Minnesota and Cornell experiments show a tendency for working maintenance per unit live weight to increase with live weight, but in neither case is this tendency statistically or practically significant.[3]

[3] It will be apparent that correlating K/W with W from equation (1) is essentially a test of the postulate that working maintenance is proportional to live weight. In a similar way, to test the postulate that working maintenance is proportional to physiologic weight, which is proportional to the .73 power of live weight, as contended by Brody (2), we would correlate $K/W^{.73}$ with $W^{.73}$. This gives, from the 25 groups of Table 1, all

TABLE 3

Digestible nutrients apportioned to lactation, working maintenance and live-weight gain
Records of Holstein cows from Cornell Experiment Station, in groups of 5.
(See footnote, page 585, for explanation of symbols.)

Group No.	Sign of ΔW*	n	Live-weight Limits, lbs.	W	$DN' = \frac{aFCM}{a}$	$DN'' = \frac{bW}{1000\ b}$	$DN''' = \frac{d\Delta W}{d}$
1	+	5	1081–1159	1126	.2815	9.05	−1.02
2	+	5	1163–1181	1171	.2607	10.19	−1.02
3	−	5	1155–1195	1173	.3047	8.30	−1.14
4	+	5	1184–1196	1191	.2460	9.63	2.61
5	+	5	1203–1220	1213	.2691	8.27	3.54
6	−	5	1203–1238	1224	.4188	4.48	−3.56
7	+	5	1220–1232	1226	.3925	5.62	1.28
8	+	5	1239–1251	1245	.0865	13.55	−.30
9	+	5	1266–1272	1270	.2395	9.86	−.74
10	−	5	1251–1331	1272	.3222	7.14	−.09
11	+	5	1272–1285	1278	.2358	8.85	3.69
12	+	5	1286–1296	1291	.2143	10.19	−.64
13	+	5	1297–1305	1300	.0457	15.11	−1.13
14	+	5	1306–1323	1314	.2564	9.21	−.75
15	+	5	1323–1333	1328	.2616	8.47	2.05
16**	+	5	1337–1344	1340	−.2435	21.87	−6.98
17	−	5	1332–1379	1355	.1959	10.04	3.86
18	+	5	1346–1375	1364	.2260	8.85	1.76
19	+	5	1382–1389	1386	.2183	9.11	1.76
20	+	4	1398–1453	1423	.3419	6.77	−2.09
21	−	4	1394–1500	1454	.2124	9.25	.91

* There are here 79 + ΔW's and 24 − ΔW's, instead of 80 and 23, respectively, in the previous paper (1). This is due to working directly with Cornell Bulletins 540 and 578, thus eliminating several errors in Missouri Research Bulletin 239. These errors are still present in Table 1.

** This group is excluded in figure 2 and in the computation of correlation, etc., on account of the negative value of a. It was found impossible to get rid of this negative value by including an adjoining group, as in Table 2.

data, $r = .17 \pm .13$; from the 16 groups of Table 2, Minnesota data, $r = .17 \pm .17$; from the 20 groups of Table 3, Cornell data $r = .10 \pm .15$. From the 36 groups of Tables 2 and 3, Minnesota and Cornell data together, $r = .29 \pm .10$, a result which borders on statistically significant evidence that the $W^{.73}$ postulate is not supported by the experimental results. Regardless of statistical significance, indicated by the "probable errors," the best estimate from the Minnesota and Cornell data, together or separately, is that working maintenance per unit live weight tends to increase with live weight. These two sets of data are given emphasis because they agree with each other (see Figure 2), and each in itself possesses a homogeneity of experimental conditions which may be lacking when the other 52 records from miscellaneous sources are included.

A point of interest is the relation between live weight and nutrients for lactation per pound of FCM, that is: the correlation between W and a of Tables 1, 2 and 3. The coefficients are, from the 25 groups of Table 1, all data, $r = -.20 \pm .13$; from the 16 groups of Table 2, Minnesota data, $r = .01 \pm .17$; from the 20 groups of Table 3, Cornell data, $r = -.22 \pm .15$.

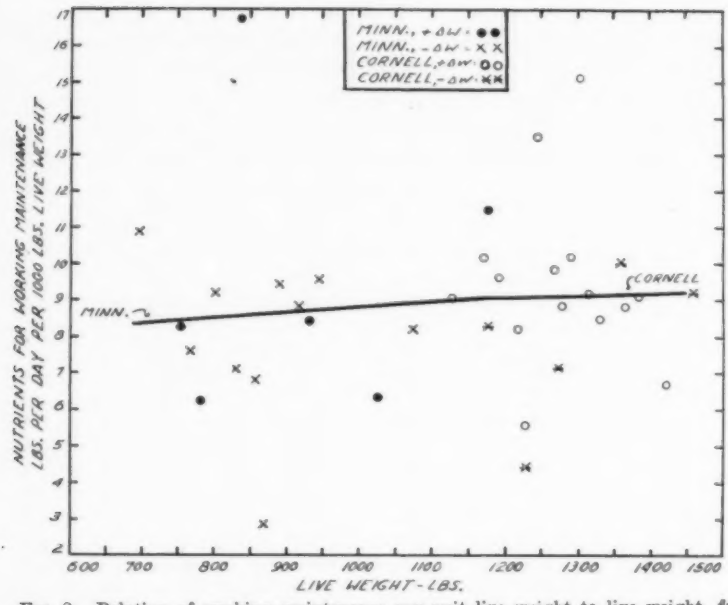

FIG. 2. Relation of working maintenance per unit live weight to live weight, from Tables 2 and 3.

DISCUSSION

It is amazing that, under the present treatment, the Cornell data show working maintenance to be proportional to live weight (or to a power of live weight slightly greater than unity), while under the former treatment (1) the same data showed working maintenance to be proportional to the .15 power of live weight, or substantially independent of live weight. In the former treatment the problem of nutrients for gain in weight, $DN'' = d\Delta W$, was summarily disposed of by assigning values to d according to the proposal of Knott, Hodgson and Ellington (3), that is, $d = 3.53$ for $+\Delta W$'s and $d = 2.73$ for $-\Delta W$'s. Could this summary procedure be responsible for the great difference in result?

For answer, the Cornell data have been reworked under the former plan but including ΔW in the normal equations, thus allowing d to find its own value from the observations themselves. Following is a comparison of the former results (1), $\Sigma D^2/(n-2)$, as against the inclusion of ΔW, $\Sigma D^2/(n-3)$, using $(n-3)$ since we now have 3 constants in the equation as fitted:

Trial value of c =	0	.15	.45	.73	1.00	1.27	2.00
$\Sigma D^2/(n-2)$, $80+\Delta W$'s =	.832	.818	.836	.907	1.017	1.159	1.628
$\Sigma D^2/(n-3)$, $80+\Delta W$'s =	.964	.637	.318	.252	.417	1.154	1.824
$\Sigma D^2/(n-2)$, $23-\Delta W$'s =	.442	.440	.548	.781	1.102	1.481	2.501
$\Sigma D^2/(n-3)$, $23-\Delta W$'s =	.356	.364	.492	.743	1.082	1.474	2.513

Inclusion of ΔW in the normal equations makes a large difference in the $+\Delta W$ records, shifting c of equation (2) from .15 to .6 (that is, between .45 and .73). Inclusion of ΔW makes little difference in the $-\Delta W$ records, shifting c from .15 to zero, or slightly less. Evidently the treatment of ΔW in the previous paper does not explain the difference in result as compared with the present paper. In equation (1) K becomes a sort of average value of working maintenance (although including all items other than FCM and ΔW) for the group. It seems worth while to apply the trial-value-of-c method of fitting equation (2) to the average DN, FCM, W and ΔW values of the groups in Table 3. This leads to the result, $c = .15$, that is, not different than previously obtained (1) from the individual records. The trial-value-of-c method amounts to a (clumsy) simultaneous solution for a, b, c and d of equation (2) and it is hard to see why it should not give right results in solving equation (2). However, since in practice it so frequently leads to nonsensical results, it should be discarded in favor of the present method of solving equation (2) through equation (1), where suitable observations are available.

Suitability of the observations depends not only on a sufficiency with respect to numbers, but also on adequacy with respect to design of the experiments. The experiments here utilized were not designed to determine the amount of nutrients used for lactation, on the one hand, and for maintenance, on the other. Thus, a major problem has been to learn the effect of varying proportions of protein in the ration, and there is the possibility that these variations may impair the value of the data for the purpose here used. In view of the great practical and theoretical importance of knowing the amount of nutrients required for lactation and the amount required for working maintenance it would be desirable to carry out experiments[4] designed for the purpose.

The Minnesota and Cornell feeding trials here utilized were largely guided by a standard assigning nutrients for working maintenance as proportional to live weight. Can this be responsible for the outcome pictured in Figure 2, indicating that working maintenance is proportional to live weight? Evidently not, at least we shall see in a later paper (to appear in the October issue of this Journal) that the direct proportionality holds in a

[4] The problem and its solution by the partition-equation method have been beautifully presented by Brody and Cunningham (4). A pedometer record of distance of travel and a record of time lying and standing would be valuable additions to the record of live weight, in the working maintenance problem. A fault of unknown influence in the present treatment is the assumption that live weight follows a strictly linear course from start to finish of the trial, whereas it is known that live weight normally follows a decidedly curvilinear course through the lactation period. That portion of the live-weight curve which is substantially horizontal should be especially suited to the equation method of evaluating the nutrient requirements for lactation and maintenance. Any long trial could well be broken up into short periods to give segments of increasing, decreasing and stationary live weights.

large body of Danish records, although the cows were fed to a working maintenance standard approximately proportional to the 2/3 power of live weight (or, substantially, in units of this paper, $DN'' = .0645\ W^{2/3}$).

The theory that maintenance is proportional to the 2/3 power of live weight has been a favorite for the reason that surface area and consequently amount of heat loss, vary as the 2/3 power of weight. An inactive dry cow may have to expend energy to keep warm, and to that extent idle maintenance may vary directly with $W^{2/3}$. An active milking cow may have to expend energy to keep cool, and to that extent working maintenance may vary inversely (instead of directly) with $W^{2/3}$. Working maintenance bears a very different relation to live weight than does idle maintenance, or especially, "basal" metabolism. We are here concerned with working maintenance of milking dairy cows, and this can be determined only under conditions of work in milk production.

CONCLUSION

It is concluded from the above results that for cows of the Guernsey, Holstein and Jersey breeds, under conditions of the experiments, a proper feeding standard is $DN = .275FCM + .009W$, where DN is pounds of digestible nutrients per day, FCM is milk-energy yield in terms of pounds of 4 per cent milk per day, and W is live weight in pounds.

REFERENCES

(1) GAINES, W. L. Working Maintenance as a Function of Live Weight in Dairy Cows, and its Bearing on an Energy-Size Index of Lactation. JOUR. DAIRY SCI. 20: 583–598. 1937.

(2) BRODY, SAMUEL. Relativity of Physiologic Time and Physiologic Weight. Growth 1: 60–67. 1937.

(3) KNOTT, J. C., HODGSON, R. E., AND ELLINGTON, E. V. Methods of Measuring Pasture Yields with Dairy Cattle. State College of Washington Agric. Exper. Sta. Bull. 295. 1934.

(4) BRODY, SAMUEL, AND CUNNINGHAM, RICHARD. Growth and Development, XXXVIII, Further studies on the Energetic Efficiency of Milk Production and the Influence of Live Weight Thereon. Univ. of Missouri, Agric. Exper. Sta. Res. Bull. 238. 1936.

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ABSTRACTS OF LITERATURE

BACTERIOLOGY

372. How Sterilizing Agents Act on Bacteria. I. L. BALDWIN, Univ. of Wisconsin, Madison, Wisconsin. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 88, 1937.

Among micro-organisms the power to reproduce is commonly accepted as the single criterion of life or death. Death of micro-organisms is usually caused by some interference with one or more of the three basic chemical equilibria on which life depends. These are the oxidation reduction equilibrium from which the energy for life processes is derived; the hydrolytic-polymerization equilibrium which is responsible for the building up and tearing apart of certain complex constituents of the cell; and the acid-base equilibrium which serves as a regulator responsible for the building up and tearing apart of certain complex constituents of the cell.

It seems probable that the lethal action of increased acidity or alkalinity upon bacteria is largely due to an increase in the rate of hydrolysis with consequent destruction of protoplasmic constituents. The action of chlorine and hypochlorites is due partially to oxidizing action and partially to their tendency to unite with protoplasmic constituents of the bacterial cell. Destructive forces are the removal of water by drying or the addition of sugar or salt. The lethal action of heat is more effective if moist or if the medium is acid or alkaline and the effect seems to be due to a combination of hydrolysis and coagulation. E.F.G.

373. Spoilage of Cream at Low Temperatures. J. A. ANDERSON, Department of Bacteriology, Rutgers University. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 19, 1937.

A new bacterium for which the name *Bacterium lipidis* is proposed exhibits powerful fat splitting action, weak action on protein, and none on sugars growing rapidly at refrigeration temperatures. A sharp throat irritation results from swallowing cream containing the organism and this is thought to be due to liberation of caproic, iso-caproic, and caprylic acids from the milk fat. Spoilage of cream at low temperature is due mainly to hydrolysis of fat and protein which accounts for the rancid and bitter flavors. E.F.G.

374. A Further Report on Tabulations of Counts Using Proposed Changes in Medium and Temperature of Incubation of Milk Samples. ERNEST KELLY, Chief, Division of Market Milk Investigations, Bureau of Dairy Industry, U. S. D. A., Washington, D. C. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 25, 1937.

Tables show that standard agar at 32° F. gives more uniform results between plants than tryptone agar at either 37° C. or 32° C. Grade A pasteurized milk seemed to be one of the few exceptions to this. There was greater variation in the results from different laboratories on the same sample of milk with the same medium than there was between the results in the same laboratory using different media and temperatures. It would seem that laboratory procedure needs to be standardized and that greater care to control conditions be exercised if satisfactory results are to be obtained. E.F.G.

375. Dairy Bacteriology. BERNARD W. HAMMER. 2nd Ed., 1938, Wiley, 482 pp., price $5.00.

Dr. Hammer has brought this book up to date by including in the second edition the main facts which have been brought out by research workers during the 10 years since the first edition was published. The book is broad in scope as evidenced by the following list of headings of the 15 chapters:

Bacterial counts of milk; milk fermentations; contamination of milk and cream and its control; growth of organisms in milk and cream; body cells in milk; spread of diseases through milk and its derivatives; preservation of milk and cream; milk enzymes; bacteriology of evaporated, sweetened condensed and dry milk; bacteriology of ice cream; bacteriology of butter cultures; bacteriology of fermented milk preparations; bacteriology of butter; bacteriology of cheese; tests for the general quality of milk and cream.

Dr. Hammer's broad experience in practically all lines of dairy bacteriology and his ability to write clearly on difficult subjects has resulted in a book which is outstanding. M.W.Y.

376. Bacterium in Milk. HERMANN OESER, Pr. Forsch. F. Milchwirtschaft in Kiel. Zentr. Bact. *2*, 96, p. 287, 1937.

The problem was to reveal which were the principal representatives of the *Bacterium coli aerogenes* group in raw market milk. The enrichments from the different media were plated on Endofuchsin agar and analyzed primarily after the technique used in German medical laboratories. Furthermore, the behavior in litmus milk, the gas formation in skimmilk at

	Indol	Meth. Red	V. – P.	Citr.	Nr. of strains
1	+	+	–	–	56
2	+	+	–	+	7
3	–	+	–	–	26
4	–	+	–	+	18
5	+	+	+	–	1
6	+	+	+	+	26
7	–	+	+	+	22
8	–	–	+	+	8

30° C., the ability to use citric acid as a sole source of carbon have been determined. The so-called reaction combinations with the known four differential tests gave results as shown in the accompanying table: Some of the combinations found by Ruehhoft *et al.* and Demeter and Sauer could not be detected. There was a remarkable constancy of the Indol and the citrate test and a more or less noticeable variability of the M. R. and V.–P. test. The gas test in skimmilk proved to be a valuable means for differentiation: typical *B. coli* strains produce only a few cc., typical *B. aerogenes* and very many intermediates, however, relatively high amounts of gas. All tests made have been summarized and there were found 25 combinations of theoretically 128 possibilities with 164 strains. Finally the author tried to put the 164 strains into the system of Bergey with the result that he got 12 subgroups. He did not encounter the 7 Escherichia species and 4 Aerobacter species of Bergey. *E. Aerogenes* does not belong to the E. A. group at all and the species *E. acidi lactici* and *E. anindolica* are to be discarded. K.J.D.

BUTTER

377. How to Determine the Keeping Quality of Butter. C. H. Parsons, Swift and Company, Chicago, Illinois. Nat. Butter and Cheese J. *29*, 7, p. 6, April 10, 1938.

Creameries need a simple test to indicate the quality which butter will have after it has passed through the regular trade channels. A test was developed which has been use for practically five years on thousands of samples of butter. This test consists of holding wrapped, printed butter which has been judged for quality for fourteen days at a temperature of 60° F. At the end of this period of time this butter is again judged for quality. The difference in score indicates the deterioration which the butter has undergone during the test. The butter is always tempered at 45 to 50° F. before judging. Careful control of temperatures of incubation is necessary. Incubation temperatures of 68 to 70° F. for a period of eight days gives approximately the same result as holding for fourteen days at 60° F. Oiling-off of the product may occur at the higher temperatures. If this occurs the test is practically valueless. W.V.P.

378. How Should Cream be Held at the Creamery? C. C. Totman, S. Dakota State College, Brookings, S. Dak. Nat. Butter and Cheese J. *29*, 8, p. 34, April 25, 1938.

Cream of No. 1 grade or better was divided into three lots and subjected to different treatments. Lot 1 was neutralized to .25 per cent acidity and pasteurized at 145° F. for 30 minutes, cooled and held in the cream vat for 4 to 15 hours before churning. Holding temperatures were 47 to 56° F. Lot No. 2 received essentially the same treatment except that it was stored

in cans for 40 to 44 hours at temperatures varying between 35 to 45° F. Lot No. 3 was held in cans for 40 to 44 hours at temperatures of 35 to 45° F. and was then neutralized and pasteurized in the manner described. Cream from Lot 1 produced butter of lower quality. The decline in scores of butter from this lot was quite noticeable during the last three months of storage. There seemed to be a slight advantage in holding cream raw under the conditions of these experiments. It is suggested that the effects of neutralizer, metallic salts and heat may be responsible for changes in the flavor of the butterfat in cream held for long periods; or that low acidity in neutralized and pasteurized cream during the holding period might favor the development of proteolytic and lipolytic bacteria. W.V.P.

Other abstracts of interest are numbers 373, 432, 447 and 459.

BUTTERMILK

379. How to Make Flake Buttermilk by Spraying Fat into Cultured Skim Milk. E. H. Parfitt. Milk Plant Mo. *27*, 3, p. 27, March, 1938.

The author presents the details of the Vogt method of making flake buttermilk by spraying liquid fat into cultured buttermilk. A comparative body and flavor study of (a) churned-cream buttermilk, (b) churned-flake buttermilk, and (c) Vogt-method buttermilk showed that the body of the churned-cream buttermilk was free from lumps and poured like sweet milk. The other two buttermilks possessed rather heavy bodies. The churned-cream buttermilk flavor was preferred by those accustomed to the "old-fashioned" buttermilk but the flavors of all three types were maintained splendidly for five days. G.M.T.

CHEESE

380. A Study of Inexpensive Pasteurizing Units for Cheese Factories. Walter V. Price and Leo Germaine. Univ. of Wisconsin, Madison, Wis. Nat. Butter and Cheese J. *29*, 7, p. 14, April 10, 1938.

Two relatively inexpensive types of pasteurizing equipment which are suitable for use in cheese factories receiving less than 10,000 pounds of milk per day are described. The bacterial destruction efficiency of these two types of equipment were tested by the plate count method. Scores are shown for cheese made from raw milk and from identical milk pasteurized by one or the other of these two types of equipment. Both methods of pasteurizing were sufficiently effective bacteriologically to improve the quality of the cheese. W.V.P.

381. Influence of Manufacturing Methods on Acidity of Brick Cheese. S. W. Spicer and Walter V. Price, Univ. of Wisconsin, Madison, Wis. Nat. Butter and Cheese J. *29*, 10, p. 18, May 25, 1938.

When brick cheese was made from pasteurized milk inoculated with commercial type *S. lactis* starter it was found that the amount of starter, the ripening period before adding the rennet, the temperature of heating, and the time of dipping the curd must be carefully controlled to produce sweet cheese of desirable quality. A development of .02 per cent titratable acidity in the whey before dipping when dipping occurred 2½ hours after setting seemed to provide a correct rate of acid development for the remainder of the process. Heating temperatures of 104° F. in conjunction with this acid development produced a pH at three days after making of approximately 5.1 with a moisture content of 38 per cent at the time of paraffining. Cheese which satisfied these characteristics was sweet and of desirable quality. W.V.P.

382. The Manufacture of Blue-veined Cheese in the Midwest. C. B. LANE, Iowa Agric. Exper. Sta., Ames, Iowa. Nat. Butter and Cheese J. *29*, 12, p. 14, June 25, 1938.

Steps in the curd-making process are described. The ripening of the cheese by mold and the use of homogenization for the milk for making blue cheese are discussed briefly. The development of commercial manufacture of the blue cheese in the United States is reviewed and the prediction is made that the demand for this domestic product should increase materially during the next few years if high quality standards are maintained.

W.V.P.

383. Rate of Ripening in Cheddar Cheese. THEODORE R. FREEMAN and C. D. DAHLE, Pennsylvania Agric. Exper. Sta., State College, Pennsylvania. Technical Bulletin 362, May, 1938.

From an economic standpoint the ripening process is one of the most important phases of cheddar cheese production. This is especially true in obtaining the desired flavor in the cheese at the time it reaches the consumer. Also, by reducing the time required to ripen cheese, the cost may be reduced.

A study was made of seventeen lots of milk which were divided into moisture, acid, Rennin, Pepsin and Trypsin Series. Each lot from the different series was divided into two equal portions and the cheese made in separate vats. One cheese from each vat was ripened at approximately 45° F. and the other at approximately 63° F.

Analysis included bacterial content and type, pH, moisture content, amino nitrogen content and flavor score, except that the nine lots in the enzyme series were not subjected to the bacterial analysis.

It is concluded that:

The rate of proteolysis in cheddar cheese during ripening is directly related to the numbers of bacteria initially found in the cheese, as deter-

mined by the total count made on lactose and skimmilk agars and by the proteolytic count made on skimmilk agar.

There is no relationship between numbers of bacteria initially found in cheese and the development of flavor in the same cheese.

Changing the moisture content of the cheese through slight modifications in the curd-making process cannot be expected to influence materially the rate of ripening in the cheese.

The rate of proteolysis in cheddar cheese ripening can be increased 40 to 100 per cent by raising the ripening temperature from 45° to 63° F.

The maximum flavor score is reached more quickly when the cheese is ripened at 63° F. than when it is ripened at 45° F.

Cheese ripened at 63° F. will attain as high a maximum flavor score as that ripened at 45° F.

Low initial acidity in the cheese is conducive to more rapid proteolysis but has no significant effect on the rate of flavor development.

The quality of the aged cheese, as judged by flavor score, is slightly inferior in the low-acid cheese.

The occurrence of bitter flavor during aging is favored by a high ripening temperature.

Bitter flavor in cheese appears to be due to the presence of one or more of the substances resulting from the breaking down of casein.

Additional amounts of pure rennin increase the rate of proteolysis in cheddar cheese ripening, increase slightly the rate at which the flavor develops, and produce an aged product with slightly higher flavor score.

Added pepsin increases the rate of proteolysis during cheddar cheese ripening particularly at the beginning of the ripening period and at the lower ripening temperature, does not accelerate the development of flavor, but produces an aged product with appreciably higher flavor score.

Trypsin increases markedly the rate of proteolysis during the early part of the ripening period, after which its effect is greatly reduced. This enzyme also increases slightly the rate at which flavor develops, but reduced the maximum flavor score attained. W.D.S.

Other abstracts of interest are numbers 432 and 459.

CHEMISTRY

384. The Effect of Excess of Vitamins A, B and C on the Assay of Vitamin D and of Excess Vitamin D on the Assay of Vitamin A. HILDA M. BRICE and GEORGINA E. PHILLIPS, Pharmacological Laboratory of the College of the Pharmaceutical Society, London. Biochem. J. *32:* 1–4, 1938.

The response by the line test technique for vitamin D was not influenced by giving, at the same time, excessive doses of vitamins A, B or C (40 γ

carotene, 10–15 I.U. B, and 0.15 mg. ascorbic acid, respectively, daily per test animal. The weight response to a small dose of vitamin A was not influenced by giving a graded series of excessive doses of vitamin D (8–100 I.U. per animal per week). It is concluded by the authors that when assaying vitamin A or vitamin D, it is unnecessary to consider the possible presence of another vitamin in the substance under test, provided the basal diet is adequate. K.G.W.

385. Buffer Intensities of Milk and Milk Constituents. III. Buffer Action of Calcium Citrate. E. O. WHITTIER, Bureau of Dairy Industry, U. S. Dept. of Agric., Washington, D. C. J. Biol. Chem. *123:* 283, 1938.

"Equations describing the buffer action of calcium citrate have been derived and curves based on these equations compared with curves constructed from potentiometric titrations of calcium citrate solutions. Support is given the Hastings-McLeon idea of the mechanism of ionization of calcium citrate in solution."

"Application of the results of milk equilibria indicates that the buffer action of citrates in milk is exerted principally in the range in which phosphates and casein buffer most intensely and is of slight moment compared with the effects of these other buffer substances." K.G.W.

386. Note on the Quantity of Theobromine in the Milk of Cows Fed on a Diet Including this Alkaloid. H. C. DOWDEN, National Institute for Research in Dairying, Univ. of Reading. Biochem. J. *32:* 71, 1938.

In 1934 it was reported that cocoa shell is rich in vitamin D, and in 1935 that the feeding of 2 pounds of shell daily for a month during the winter raised the vitamin D content of the milk of stall-fed cattle to the normal summer level, while in 1937 it was found that the fat content of these milks was increased during the period of shell feeding.

Cocoa shell contains approximately 3 per cent of theobromine, and a cow receiving 2 pounds daily of the shell would receive approximately 9 grams of the alkaloid. Theobromine was fed in 9 gram quantities daily to a small group of cows for 3 weeks and on the last day samples of milk were analyzed for theobromine content. It was observed that in the milk of three cows the average daily milk yield of which was approximately 35, 19 and 18 pounds, the "theobromine" was respectively 4.71, 2.05 and 4.72 mg. per liter. In blank tests upon the method, yields of approximately 70 per cent of added theobromine were obtained. The maximum content of theobromine transmitted to the milk of the above three cows is, therefore, approximately 7 mg. per liter. According to a supplementary publication of the British Pharmacopoeia, the medicinal dose of theobromine is 0.3–0.6

gram. For a child under 12 months, for whom the dose would be $\frac{1}{12}$ of that prescribed for an adult, the minimum dose is contained in $6\frac{1}{4}$ pints of the milk. Plain eating chocolate contains approximately .3 per cent theobromine, and it is not uncommon for $\frac{1}{4}$ pound of this chocolate (containing 0.3 of theobromine) to be eaten by an adult at one time. K.G.W.

387. Analysis of Proteins. IX. The Content in Amino Acids of the Caseinogen and Lactalbumin of Woman's Milk. R. H. A. PLIMMER and J. LOWNDES, Chem. Dept., St. Thomas's Hospital Medical School, London, S.E. 1. Biochem. J. *31:* 1751, 1937.

The protein of cow's milk and woman's milk was concurrently analyzed for amino acid content. To compare the nutritive value of the protein of cow's milk with woman's milk, the cow's milk was generally diluted with an equal volume of water.

Except for cystine, which is the same in amount in cow's and woman's milks, cow's milk contains $\frac{3}{4}$ times the amounts of the other amino acids. Cow's milk diluted with an equal volume of water will contain half the amount of cystine present in woman's milk. If diluted with two volumes of water then tryptophane and possibly arginine will be below the amounts in woman's milk. Cow's milk diluted with an equal volume of water will have an equal amount of the sum of the sulphur bearing amino acids, cystine and methionine. K.G.W.

388. Dialysis of Milk. III. Salt Equilibrium with Special Reference to Calcium, Magnesium, and Phosphorus. L. H. LAMPITT, J. H. BUSHILL and D. F. FILMER, Lyons Laboratories, London, W. 14. Biochem. J. *31:* 1861, 1937.

It has been previously shown by these authors that the acidity of milk is of distinct importance in determining the dialysability of certain constituents, particularly salts. The results of this study show that acidification with either diluted or concentrated acids had the same effect on the amount of dialysable constituents.

Neutralization of acidified, raw, separated milk results in an almost complete recovery of the original amounts of dialysable Ca, Mg and inorganic P, although the figure for Ca remains slightly above normal.

The effect of extended agitation (14 days) on the dialysable constituents was studied. It is suggested that the salt equilibrium of milk is normally unstable and may be shifted by agitation. Treatment of the milk in its preparation for milk powder appears to stabilize the salt equilibrium.

The following ranges of analytical figures are presented for raw, pasteurized and dried, separated, "average" milk.

	Total	Dialysable (as % of total present)
Inorganic P	0.63–0.77	33–44
Organic P	0.31–0.38	7–15
Ca	1.27–1.44	25–42
Mg	0.10–0.15	62–83

K.G.W.

389. The Milk Clotting Action of Papain. A. K. BALLS and S. R. HOOVER, Bur. of Chem. and Soils, U. S. D. A., Washington, D. C. J. Biol. Chem. *121:* 737, 1937.

The milk clotting component of papain appears to possess activity in agreement with the conception for papain proteinase. The component is activated by H_2S, cysteine, phenylhydrazine, and cyanide, and has a high temperature optimum.

The time required for clotting was shown to be a straight line function of the enzyme concentration; a quantity of the enzyme, constant for any condition, is inactivated by the milk. K.G.W.

390. The Position of the Unsaturated Linkage in the Hexadecenoic Acids of Certain Natural Fats. JOHN M. SPADOLA and R. W. RIEMENSCHNEIDER, Bur. of Animal Ind., U. S. D. A., Washington, D. C. J. Biol. Chem. *121:* 787, 1937.

The hexadecenoic acid present in goat milk fat, egg yolk glycerides, and the depot fat of the white rat is chiefly the 9-, 10-hexadecenoic acid.

K.G.W.

DISEASE

391. Sterility in Cattle Symptom not Disease. C. R. DONHAM, Ohio Agric. Exper. Sta., Wooster, Ohio. Ohio Exper. Sta. Weekly Press Bull. XXIII–18, July 7, 1938.

Sterility in cattle is not a specific disease, but symptom of a large number of different diseases. Appropriate treatment can be applied only after intelligent diagnosis by a competent veterinarian. W.E.K.

392. Results of Calfhood Vaccination. L. J. TOMPKINS, Sheffield Farms Company, N. Y. Cert. Milk *13,* 141, p. 7, Jan., 1938.

This article summarizes the results up to date of a field experiment in calfhood vaccination for Bang's disease which was started in January 1934. The results of the research work done show that when calves are vaccinated between the ages of four and eight months with an appropriate vaccine, the agglutination titre disappears in a relatively short time, leaving the animal immunized to some degree. W.S.M.

Another abstract of interest is 401.

FOOD VALUE OF DAIRY PRODUCTS

393. Milk the Most Perfect Food. N. N. GODBOLE, Benares Hindu Univ., Dipawali, India, 1936. Distributed by Chemical Publishing Co., 148 Lafayette St., N. Y.; Price $1.25.

The title of this book is not sufficiently broad to include the full text, for the author really presents the dairy industry of India with special reference to improvement of the Hindu diet through increased consumption of dairy products. For American readers this style is particularly interesting for the literature on the food value of milk has not been materially increased by researches in India while knowledge of dietary conditions in India is not too general.

The promotion of the vegetarian diet is uppermost in the thoughts of the author which is essential in India for both religious and health reasons. India has neither supervision of the slaughter and handling of meats nor refrigeration in a country where summer temperatures are usually above the temperature of the human body. Fortunately, for the nutrition of the people, milk is accepted in the vegetarian diet for life need not be destroyed to secure it. Milk is served fresh in fluid form, or as ghee, butter, and fermented drinks. The total per capita yearly milk consumption is only about 85 pounds, caused principally by the very low production of the cattle. It is estimated that India has 52,500,000 milk cows and 20,500,000 she-buffaloes, the former producing 100 pounds and the latter 1200 pounds of milk per year in excess of that required by the calves.

The material in this book is presented in a very elementary manner for general public reading. Some printing errors are obvious, and exception may be taken to some of the ideas expressed by the author. Nevertheless, the book is both interesting and informative. A.C.D.

394. The Value of Milk Protein in Infant Feeding—Part II. P. B. CASSIDY and H. H. PERLMAN, Pediatric Society, Philadelphia, Pa. Cert. Milk *12*, 139, p. 5, Nov., 1937.

A discussion on the following questions:

1. Is the protein of cows' milk a cause of infantile eczema?
2. Does a high temperature have a favorable or unfavorable effect upon the protein in cows' milk?
3. What is the nutritional physiologic significance of milk protein?
4. What is the comparative economic status of milk protein as found in the various forms of milk: whole milk, evaporated milk, etc.?

W.S.M.

395. The Cow—"Mankind's Foster Mother." W. E. KRAUSS, Ohio Agric. Exper. Sta., Wooster, Ohio. Cert. Milk *12*, 140, p. 7, December, 1937.

This paper discusses the relationship between the feed of the cow and the composition of the milk, emphasizing the vitamin content.

W.S.M.

396. Soft Curd and Homogenized Milks. IRVIN J. WOLMAN, School of Medicine, Univ. of Pennsylvania, Philadelphia, Pennsylvania. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 114, 1937.

The pH of the stomach contents of a healthy infant seldom falls below 5.0. The iso-electric point of casein is 4.7 while the optimum pH for action of pepsin is 2.8. Acidity in the stomach of the infant is not favorable for action of pepsin, but in the young adult stomach a pH of between 3.0 and 1.4 is reached so active digestion by pepsin is obtained.

An artificial digestion device in which milk and milk formulae were subjected to the chemical action of synthetic gastric juice made from hydrochloric acid and pepsin is described. The production of fine soft curds by the addition of banana powder and banana pulp is described. Commercial methods of producing soft curd milk are briefly discussed. Clinical evidence shows that the milk preparations which yield soft curds are well tolerated and well utilized by infants, children and older persons, and that soft curds mean fine curds. Better control and standards are needed for these products.

E.F.G.

397. Lime and Phosphorus, and Their Significance to the Milk Dealer. WALTER H. EDDY, Columbia Univ., New York City. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 96, 1937.

The role of calcium and phosphorus in nutrition is discussed. Dr. Sherman in recommending a quart of milk per day for growing children bases this upon the fact that the child needs about 1 gram of calcium per day for body maintenance and growth and this is contained in the quart of milk. Milk is a better source of calcium than vegetables. Utilization of calcium and phosphorus is dependent upon vitamin D. A more acid condition in the digestive tract favors solubility of calcium. The parathyroid gland has a specific effect upon calcium assimilation. An outline is given of a procedure to check satisfactory calcium and phosphorus assimilation.

E.F.G.

398. The Effect of Season and Feeds on the Vitamin D Content of Milk Under South Dakota Conditions. G. C. WALLIS and T. M. OLSON, South Dakota Agric. Exper. Sta., Brookings, So. Dakota. So. Dakota Exper. Sta. Bull. No. 321, March, 1938.

Six grade Holsteins were used to study the effect of the season of the year and of the feeds consumed by dairy cows on the vitamin D content

of the milk produced. A marked seasonal effect was found. Summer milk contained 32 International Units of vitamin D per quart which was about four times the amount of vitamin D contained in the winter milk produced under the conditions of this experiment.

The vitamin D in the feed eaten by the cow also had an important influence on the amount in the milk produced. When the vitamin D intake was increased the milk became proportionately richer in this important food factor. The alfalfa hay used in this experiment contained 500 International Units of vitamin D, and the Prairie hay 250 International Units of vitamin D per pound. The hay was fed at the rate of 20 pounds per day so the cows getting alfalfa hay received 10,000 International Units of vitamin D daily, and the cows getting prairie hay received 5,000 units. This difference in intake was reflected in the higher vitamin D content of the milk produced by the cows receiving alfalfa hay. However, only a small proportion (between 1 and 2 per cent in this case) of the vitamin D in the feed consumed was recovered in the milk.

Because of the importance of milk as one of the few food sources of vitamin D, advantage should be taken of all factors which will contribute towards increasing the antirachitic value of milk. Some of these factors have been indicated in this bulletin while others will require further study. C.C.T.

399. What If There Were No Milk? NINA SIMMONDS, College of Dentistry, Univ. of California. Milk Plant Mo. *27*, 2, p. 32, Feb., 1938.

Milk is discussed chiefly from the standpoint of its calcium content, the role of which in dentition is emphasized. G.M.T.

400. A Note on the Vitamin D Content of Cow's Colostrum. KATHLEEN M. HENRY and S. K. KON, National Institute for Research in Dairying, Univ. of Reading. Biochem. J. *31:* 2199, 1937.

The vitamin D content of the colostral fats of a Guernsey cow on pasture was 1.2 I.U. per gram for the 0 and first day *post partum*, 0.56 I.U. per gram for the second, third, and first half of the fourth days, and 0.36 I.U. per gram for the last half of the fourth and first half of the fifth days. Normal control butterfat from a cow on the same ration contained 0.41 I.U. per gram. Compared with later milk, colostrum contains relatively more vitamin A and carotene than vitamin D. K.G.W.

401. The Relation of Fat to the Utilization of Lactose in Milk. E. J. SCHANTZ, C. A. ELVEHJEM and E. B. HART, Dept. of Agric., Univ. of Wisconsin, Madison, Wis. J. Biol. Chem. *122:* 381, 1938.

Rats placed on a mineralized whole milk diet made very efficient utilization of all the milk sugar. This has also been found to be true for a pig

and a calf. When the animals were placed on a mineralized *skim* milk diet, sugar was readily detected in the urine after a few days of feeding. The sugar was identified as galactose and accounted for all of the reducing material in the urine. In the case of the rat, as high as 35 per cent of the ingested galactose was recovered in the urine. Fats such as butterfat, lard, corn oil, cocoanut oil, linseed oil, and palmitic and oleic acids, when added to mineralized skim milk at levels of 3 to 4 per cent, prevented this loss in the urine. Glycerol or butyric, β-hydroxybutyric, caproic, and lactic acids did not prevent the loss. On mineralized skim milk the sugar of the blood rose to about 200 mg. per cent, while on whole milk it seldom rose higher than 140 mg. per cent after feeding. K.G.W.

Other abstracts of interest are numbers 384, 386, 387, 428, 444 and 454.

HERD MANAGEMENT

402. Some Calf Disorders of Nutritional Origin. C. E. KNOOP, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bull. No. XXIII–6, Apr. 14, 1938.

Many calf disorders may have nutritional origin, chiefly because of lack of certain minerals and vitamins. Lack of vitamin A and iodine are cited particularly. W.E.K.

403. Grain, Silage, Hay Supplement Pasture. A. E. PERKINS, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Agr. Exp. Sta. Weekly Press Bull. XXIII–10, May 12, 1938.

It is pointed out that it is seldom economical to attempt to compensate for all the deficiencies of poor pasture by means of grain only. The use of silage, hay, or a cultivated pasture crop, such as Sudan grass, in connection with a low rate of grain feeding, is recommended.

W.E.K.

404. Pasture, Cause of Milk Slump. C. F. MONROE, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bull. No. XXIII–16, June 23, 1938.

The marked decline in milk production often experienced after the first flush from pasture is probably due to an actual shortage of palatable grass. To prevent this drop the practice of rotating pastures is suggested.

W.E.K.

ICE CREAM

405. The Merchandising Council in 1937. G. V. RECTOR, Fairmont Creamery Co., Omaha, Neb. Proc. 37th Ann. Conv. Int. Assn. of Ice Cream Mfrs. *4:* 7, 1937.

During the past year the activities of the Ice Cream Merchandising Institute were increased. One important phase of the work was a series of 14 two-day regional merchandising conferences, so planned that they fairly covered the country geographically.

The monthly publication of the institute, "The Spinning Wheel," was continued for the benefit of sales and advertising managers of ice cream companies. Another monthly publication, "Ice Cream Currents," is planned primarily for the retail dealer. Ice cream manufacturers can purchase copies at 4 cents per copy for distribution to their dealers. Two talking slide films have been prepared for use by ice cream merchandisers; the one is intended for showing to retail dealers, the other is of interest to consumers.

The Ice Cream Merchandising Institute also offers personal information service to manufacturers with specific ice cream merchandising problems.

M.J.M.

406. What Have You to Sell? GEORGE W. HENNERICH, Ice Cream Merchandising Institute, Inc., Washington, D. C. Proc. 37th Ann. Conv. Int. Assn. of Ice Cream Mfrs. *10:* 4, 10, 1937.

The importance of a constructive selling program is stressed by the author. Merchandising of ice cream at the soda fountain is then discussed from the standpoint of profitable operation. The home delivery of ice cream was also found to be a profitable way of selling the product.

M.J.M.

407. Showmanship in the Ice Cream Industry. ZENN KAUFMAN, New York, N. Y. Proc. 37th Ann. Conv. Int. Assn. of Ice Cream Mfrs. *10:* 4, 20, 1937.

The author discusses the elements which he feels are essential in successful salesmanship and gives numerous illustrations of how these elements have been successfully employed. M.J.M.

408. Specialties—Their Place in Industry. NORMAN THOMAS, Joe Lowe Corp., New York, N. Y. Proc. 37th Ann. Conv. Int. Assn. of Ice Cream Mfrs. *10:* 4, 35, 1937.

Although bulk ice cream is the mainstay of the ice cream industry, it is true that a greater number of flavors and specialties will increase the gallons of ice cream sold in any store. Specialties which are properly packaged, stored and handled will add to the profits of an account. The ice cream salesman is urged to determine the relative amount of profit for bulk ice cream and specialties and properly instruct the retail dealer along these lines.

The ice cream maker is urged to handle only such specialties or novelties

which offer the basis of size and price control. Oversized and underpriced novelties have been the source of a considerable amount of trouble. Legal size and price control have protected numerous markets from difficulty with specialties. M.J.M.

409. Retail Store Trends. O'NEAL M. JOHNSON, Statistical and Accounting Bureau, I. A. I. C. M., Washington, D. C. Proc. 37th Ann. Conv. Int. Assn. of Ice Cream Mfrs. *10:* 4, 44, 1937.

The author has found that 23.9 per cent of the manufacturers sell ice cream through retail stores, but the ice cream sold in this manner represents only 11.5 per cent of the total sales. Only 15 per cent of the ice cream manufacturers operate more than one retail store.

The types of stores operated, the kind of merchandise featured, the average selling prices, and the kinds of cones sold are tabulated for the ice cream stores studied. A considerable amount of data are presented and many problems arising in retail selling are discussed. A manufacturer who is considering the sale of ice cream through retail stores should find this information very helpful. M.J.M.

410. Retail Stores. A Discussion. Proc. 37th Ann. Conv. Int. Assn. of Ice Cream Mfrs. *10:* 4, 68, 1937.

(1) LLOYD D. WITTER, Snowhite Creameries, Inc., San Angelo, Texas.

With the advent of new developments, the ice cream industry has been changed from time to time. The retail store is a present day trend which may mean another transition point in the industry. The retail store came into existence in the depression years as a result of intense competition and decreased gallonage of sales through the regular outlets. The place of the retail store in the industry is questioned by some and upheld by others.

Retail stores will continue to be successful so long as the public is offered: Products of quality; A variety of flavors; Attractive surroundings; Convenience and service; And, most important, values.

(2) D. H. DORMAN, Protected Milk Products, Kansas City, Missouri.

Our company has operated a few retail stores over a period of four years. Until the past year the stores were not equipped for Fountain service. The addition of the fountain stores proved very successful. The retail store also proved to be very helpful in promoting specialties.

(3) E. B. DARROW, Darrow Ice Cream Co., Albuquerque, New Mexico.

Our experience with a retail store has been over only a five months' period. Nothing but package goods is sold—brick ice cream and five-cent items in package. No attempt was made to call attention to the retail store, by advertising. Yet through the store as much brick ice cream has been sold as by the ten best dealers handling our ice cream. We have found that packaged ice cream can be sold successfully through the retail store.

(4) CARL A. STEEL, Steel De Soto Ice Cream Co., Minneapolis, Minn.

A retail store was opened by our company in a town where the company operated two ice cream routes. After a few months it was found that more ice cream was being sold through the store than through the two routes.

It is believed that operating both a retail and wholesale ice cream business on a large scale is not practical. However, by operating a few retail stores it might be possible to show the dealer how to merchandise ice cream successfully by operating his store as an ice cream store during the short busy season.

(5) G. D. TURNBOW, Protected Milk Products Co., Oakland, California.

The retail store spread is only one of several fundamentals in successful operation of this type of business. Such elements as the traffic count, location of store, construction of store, products to be sold, and many other details, must be decided on before retail store spread becomes a factor.

We have found it difficult to find properly trained personnel and managers for the ice cream stores. Volume is also essential. A successful store must handle in excess of 5,000 gallons a year.

With ice milk, a gross spread of 47 per cent should be realized. Our aim for an average spread on all products is 42.5 per cent.

The proper training of new employees is paramount. They are first trained in a manner similar to that used in the classroom. Following this they work for a period of time under a trained supervisor.

The store manager is given a bonus for obtaining sales quotas on certain products and on the entire quota for the set up for the month. In addition, a special bonus is given to the managers who maintain the required store spread for the month. M.J.M.

411. **Sodium Alginate—A Stabilizer.** V. C. STEBNITZ and H. H. SOMMER, Dept. of Dairy Industry, Univ. of Wis., Madison, Wis. Ice Cream Field *32*, 3, p. 48, March, 1938; 4, p. 52, April, 1938.

The authors compared the stabilizing properties of sodium alginate (Dariloid) with those of gelatin of the following Bloom strengths 150, 175, 200, 225 and 250. The mixes were prepared in accordance with commercial practice except that they were processed in much smaller batches. The ice cream was frozen using a 2½ gallon vertical brine freezer.

The authors report that the addition of 0.2 per cent "Dariloid" caused an increase of 0.08 to 0.10 in the pH of the mix whereas 0.3 per cent "Dariloid" resulted in an increase of 0.13 to 0.17 pH. These additions caused a decrease in titratable acidity of 0.10 and 0.015 per cent respectively.

In contrast with the above, the various gelatins caused no appreciable change in either the pH or titratable acidity when added to the mix.

Mixes containing gelatin were found to have the same color as the control mix without any stabilizer, while the sodium alginate mixes showed slightly more color.

Measurements of viscosity showed the sodium alginate mixes to be more viscous than gelatin mixes when freshly prepared, whereas after aging this difference did not necessarily persist. They report that agitation of the sodium alginate mix caused a considerable decrease in viscosity which was not regained by subsequent aging.

No tendency to whey off occurred with the sodium alginate or gelatin mixes.

When sodium alginate mix was cooled to 60° F., aging seemed to improve its whipping ability whereas if cooled to 40° F. immediately after homogenization, aging did not improve the whipping property. The authors state "The difference in whipping ability between gelatin and sodium alginate seems to depend to a large extent upon the condition of the freezer and the amount and strength of the gelatin used—Excessive amounts of sodium alginate seemed to have the same deterrent effect on the whipping ability as excessive amounts of gelatin."

According to the authors there was practically no difference in body and texture of ice creams made with sodium alginate and gelatin when the correct amount of each was used.

The authors claim "As a stabilizer for ice cream, sodium alginate shows all the desirable properties of the other ice cream stabilizers and in addition shows some distinct advantages." In this connection they emphasize particularly the advantage of uniform viscosity during the aging of sodium alginate mixes. W.C.C.

412. Viennese Ice Cream Stresses Flavor. ANONYMOUS. Ice Cream Field *32*, 3, p. 54, March, 1938.

Viennese ice cream, according to Sidney Freier, an ice cream manufacturer of Vienna, is made with egg yolks (10 to 20 yolks for 1 quart of ice cream), milk, cream, butter and 18 per cent sugar. He claims the flavor must be very pronounced, *e.g.*, 30 to 40 per cent crushed fruit is used in Viennese fruit ice cream; the taste is never doubtful.

Coffee is the most popular flavor in Vienna followed by nougat or hazelnut. Strawberry is also a popular flavor, but vanilla and chocolate are in little demand.

Mr. Freier feels that more emphasis should be placed upon flavor in this country, but he is impressed with the magnitude speed and efficiency of American machines. W.C.C.

413. The Small City Plant. M. W. YALE and R. C. HICKEY, N. Y. Agr. Exp. Sta., Geneva, N. Y. Ice Cream Field *32*, 3, p. 34, March, 1938.

"In general, venders of ice cream take poor sanitary care of dippers and scoops" according to the authors. They claim further that small

retailer manufacturers are, as a group, least familiar with sanitary principles.

They state further, "the greatest need for improvement in sanitation appears to be in the dispensing of bulk ice cream in a cleaner and more sanitary manner. However, this need is no greater than that for improvement in the handling of many other foods and beverages; and it is doubtful whether ice cream should be singled out for action. The whole question of sanitation in respect to food handling is receiving and should receive much attention at the present time." W.C.C.

414. The Use of Lecithin. J. H. Erb and H. Collins, Ohio State Univ., Columbus. Ice Cream Field *32*, 5, p. 42, May, 1938.

Dipping chocolate bars ordinarily results in the incorporation of some moisture in the coating which increases its viscosity and decreases the amount of surface coverage. The addition of 0.2 to 0.4 per cent lecithin tends to reduce the increase in viscosity due to water dilution. W.C.C.

415. Egg Yolk as a Mix Ingredient. C. D. Dahle, Penn. State College, State College, Pa. Ice Cream Field *32*, 5, p. 25, May, 1938.

The author points out that since 1920 the commercial use of egg products for ice cream manufacture has increased materially. Egg yolk improves the whipping properties of ice cream mixes especially those made with butter or frozen cream as the sources of fat. Often beneficial results are also obtained from its use in chocolate ice cream.

The various types of egg products available for use in ice cream are considered and a brief discussion presented as to the possible constituents of egg yolk which may be responsible for the improved whipping qualities of the mix. W.C.C.

416. Use of Anti-Oxidants in Ice Cream. A. C. Mack and P. H. Tracy, Dept. Dairy Industry, Univ. of Ill., Urbana, Ill. Ice Cream Rev. *21*, 6, p. 82, Jan., 1938.

Oat flour was added to ice cream mixes containing three p.p.m. of added copper. The amount of oat flour added ranged from 0.1 to 0.5 per cent. In order to be assured of ample anti-oxidative protection in vanilla ice cream it is recommended that 0.5 per cent oat flour be added. Various methods of adding oat flour to the mix were studied. The most satisfactory methods were to add the oat flour to the mix with the sugar or to add it in dry form at the freezer. It was found more difficult to control the development of stale metallic flavor in strawberry ice cream by the addition of oat flour than in vanilla ice cream. Oat flour added at the rate of 0.5 per cent delayed the oxidized flavor development. J.H.E.

417. Profitably Priced Packages Preferred. J. H. CAROTHERS, Los Angeles, California. Ice Cream Rev. *21*, 9, p. 44, April, 1938.

In order to give the consumer a better quality and more fairly priced package the overrun should be controlled, and a price should be set on the package which would allow a fair margin of profit, to the manufacturer and the dealer. It is suggested that the price be set on a unit basis so the dealer will know a certain profit will be made on each individual unit sale.

J.H.E.

418. A Study of the Qualities of Commercial Ice Cream. W. H. BROWN, Dairy Dept., Purdue Univ., Lafayette, Indiana. Ice Cream Rev. *21*, 9, p. 110, April, 1938.

Analytical and bacteriological results compiled on 570 samples of commercial ice cream at Purdue University are tabulated and discussed.

J.H.E.

419. Controlling Stale Flavors in Ice Cream. K. G. WECKEL, Dept. of Dairy Industry, Univ. of Wis., Madison, Wis. Ice Cream Rev. *21*, 9, p. 35, April, 1938.

State flavors in ice cream originate through the use of inferior ingredients, inadvertent equipment effects, and slow turnover of the product. Contributing factors to each of the above are discussed and precautions and remedies suggested. J.H.E.

420. Ice Cream Regulations. M. G. YOUNG, Missouri Dept. of Health. Ice Cream Rev. *21*, 6, p. 28, Jan., 1938.

The consumer of ice cream and other dairy products is entitled to the same health protection as the consumer of a bottle of fluid milk. Factors discussed are the regulation of the raw products going into ice cream, the control problems arising since the development of counter freezers, the question of requiring pasteurizing of mix and manufacture of ice cream to be a continuous process, and the sanitary conditions of the retail outlet.

J.H.E.

421. Refrigeration in the Ice Cream Industry. W. L. PHARO, York Ice Machinery Corp., Charlotte, N. C. Ice Cream Rev. *21*, 9, p. 46, April, 1938.

The most common cause of inefficient refrigeration plant performance can be credited to high condensing pressures. An illustration is given showing the increased cost of operation due to excessive head pressure. The most common causes of high pressures are non-condensable gases in the system, dirty condensers, lack of condensing water or condensing water not cool enough, and lack of sufficient condensing surface. J.H.E.

422. Frosted Malted. ANONYMOUS. Ice Cream Field *32*, 1, p. 7, Jan., 1938.

Frosted malted milk is not ice cream, instead it is a sherbet with low butter-fat content. It has been characterized as the "drink you eat with a spoon," actually it is a semi-frozen product that is eaten with a spoon.

Special mixers are used for making this product which are illustrated.

Under the caption "How it's done" is given a formula for the manufacturer and one for the retailer. W.C.C.

Editor's Note. "This product is what is generally known as 'Ice Milk.'"

423. Frosted Malteds. ANONYMOUS. Ice Cream Rev. *21*, 10, p. 32, May, 1938.

A large wholesale ice cream manufacturer introduced a Frosted Malted ice milk and secured highly satisfactory results by adding milk to the product and mixing it on a fountain mixer. It is a product low in fat content and high in total solids making it an ideal hot weather drink. A formula is given for its manufacture. J.H.E.

424. Large Scale Production of Fancy Ice Cream, Chocolate-Coated Bars and Specialties. CHARLES WEINREICH, Cherry-Burrell Corp., Chicago, Ill. Ice Cream Rev. *21*, 10, p. 88, May, 1938.

Consumption of ice cream novelties has increased until today about 25 per cent of all ice cream manufactured is in this form. Several methods are outlined for the production of chocolate-coated ice cream bars. J.H.E.

425. Routine Calculation of Ice Cream Mixes. CARL DUNCAN. Ice Cream Rev. *21*, 8, p. 41, March, 1938.

Instruction, using sample mixes for demonstration, is given for standardizing the ice cream mix. J.H.E.

426. The "Big Ten" in Ice Cream Merchandising. R. F. GILBERT, Hydrox Corp., Chicago, Ill. Ice Cream Rev. *21*, 9, p. 96, April, 1938.

Ten specific points are suggested for successful ice cream merchandising at the soda fountain. J.H.E.

427. Making Ice Milk Mix from Ice Cream Mix. H. A. COLLINS, San Jose, California. Ice Cream Rev. *21*, 10, p. 38, May, 1938.

Calculations are explained for standardizing ice milk from regular ice cream mix. J.H.E.

428. Ice Milk. G. D. TURNBOW, Oakland, California. Ice Cream Rev. *21*, 10, p. 30, May, 1938.

The author justifies the existence of ice milk, a product similar to ice cream, but containing only 4 per cent milk fat. He states it merits development and regulation because it is a tasteful confection, it has exceptional food value, and is important in the economic structure of the dairy industry. The author states that in 1936 California produced 15,664,734 gallons of ice cream and 7,190,587 gallons of ice milk. J.H.E.

429. Diabetic Ice Cream. B. E. HORRELL, Dairy Dept., Purdue Univ., Lafayette Indiana. Ice Cream Rev. *21*, 10, p. 46, May, 1938.

Two formulas for ice cream suitable for people afflicted with diabetes are given. Saccharin is the sweetener in place of sugar. J.H.E.

430. Seasonal Specialties. JOHN CLAITOR. Ice Cream Field *32*, 3, p. 42, March, 1938.

Several recipes are given for small ice cream manufacturers who are not equipped to homogenize their mixes. W.C.C.

431. Bacteria in the Mix. D. LEVOWITZ, New Jersey Laboratories. Ice Cream Field *32*, 9, p. 10, March, 1938; *32*, 4, p. 23, April, 1938; *32*, 5, p. 15, May, 1938.

The author attempts to describe some of the elementary principles of microbiology in very simple terminology. Different types of organisms are illustrated, some of the sources of contamination discussed and desirable practices indicated. W.C.C.

Other abstracts of interest are numbers 372, 373, 375, 447, 449, 450, 452, 455, 459, 463 and 464.

MILK

432. Seasonal Changes in Market Milk Production in Pennsylvania. The Relation of Month-to-month Fluctuations in Milk Sales to Prices Received by Farmers. F. F. LININGER and C. W. PIERCE, Pennsylvania Agric. Exper. Sta., State College, Pa. Bull. 358, April, 1938.

There is a wide variation in the amount of milk produced during the different seasons of the year. In many cases there is twice as much shipped in June as there is during the month of November. Records of milk shipments indicate a trend toward more variable production in the Philadelphia and Pittsburgh milk sheds following the abandonment of the base-surplus plans a few years ago. Seasonal sales of milk from farms have always

varied widely in the New York milk sheds, where no plan for the specific purpose of leveling production has ever been in general use.

The report deals with the seasonal production, distribution of sales and prices for the three large markets, New York, Pittsburgh, and Philadelphia, drawing supplies from the state of Pennsylvania.

The average per cent of milk received by these three markets during the month of November was 78.3 per cent while in June it was 131 per cent, using 100 per cent as the average for the year. In the Philadelphia market during the month of November 87.6 per cent of the milk received was used for fluid milk purposes, while in June only 58 per cent of the milk received was used for fluid milk purposes.

Because fluid milk distributors must have an adequate supply of milk during the low periods of production, they have a supply in excess of their fluid requirements during the remainder of the year as a result of fluctuating production.

The average price paid producers depends largely on the percentage of the total supply sold for fluid uses. Therefore, prices are higher in the fall and winter months than during the spring and early summer months. Production is more varied in both the Pennsylvania section of the New York milk shed and in the Pittsburgh milk shed than in the Philadelphia milk shed. Seasonal fluctuation in production in the Pittsburgh and Philadelphia sheds have increased since the discontinuance of the "basic-surplus" plans during 1933 and 1934. For all groups of producers seasonal fluctuations in production have widened since 1933.

A trend toward uneven milk production tends to widen a milk shed; to increase the cost of marketing by requiring additional investments in plants, equipment and trucking facilities necessary to handle peak summer milk supplies; and to increase seasonal fluctuations in average prices paid to producers for milk.

The present price system in Pennsylvania favors uneven production. For this reason many producers have been demanding a change in price policies which would favor even production. W.D.S.

433. The Use of Citric Acid and Sodium Citrate in Milk and Milk Products. HUGH L. TEMPLETON, Univ. of Wisconsin, Madison, Wis. Wis. Agric. Exper. Sta. Res. Bull. 133, Nov., 1937.

Judges preferred those starters containing either citric acid or sodium citrate. The addition of citric acid or sodium citrate to the starter culture or to the cream to be used for butter-making, or both, seems to give a butter with a more pronounced flavor and aroma. The addition of two to six ounces of sodium citrate per thousand pounds of cream is effective for preventing feathering of cream because it counteracts the effect of calcium salts in either the water or the cream. The use of limited amounts of sodium citrate in

cream tends to minimize the cream plug defect and although large amounts completely eliminate cream plug, the flavor of the cream is affected adversely. Experiments with whipping cream show the addition of sodium citrate decreases the whipping time when the fat content of the cream is less than 35%. Other factors influencing the whipping of cream, such as fat content, temperature of pasteurization and the like were studied experimentally. Brief comments indicate the possible application of sodium citrate for stabilizing condensed milk, for aiding the ripening of natural cheese and for the production of soft-curd milk. Citric acid may be used advantageously in milk for infant feeding under a doctor's direction. W.V.P.

434. Base and Surplus Plans Level Out Milk Production. R. W. SHERMAN, Ohio Agric. Exper. Sta., Wooster, Ohio. Ohio Exper. Sta. Weekly Press Bull. No. XXIII–19, July 14, 1938.

Base and surplus plans in four Ohio markets have been an influence in leveling out the yearly supply of milk. In some instances the difference between the flush and shortage months was 10 pounds less per day than before the plan was in operation. W.E.K.

435. Evaluation of Methods of Determining the Efficiency of Pasteurizing Milk. E. H. PARFITT, Univ. of Purdue, Lafayette, Indiana. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 183, 1937.

The value of comparison of laboratory and commercial pasteurization, line testing, line bottle testing and coliform content is discussed and some figures given showing how each criterion is used. The author states the coliform content is one of the best. E.F.G.

436. The Causes of Off-flavors in Milk; the Facts and a Theory. J. A. ANDERSON, S. T. WILSON, and J. G. HARDENBERGH, Rutgers Univ., New Brunswick, New Jersey. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 177, 1937.

The authors' theory is that the oxidized, rancid, flat and insipid flavors which develop in milk of low bacterial content have their origin in a carotene deficiency in the ration. This effects the milk directly by reducing its carotene content and what appears to be more important causes a vitamin A deficiency in the cow which results in an abnormal distribution of enzymes in blood and milk. This accounts for excessive amounts of lipase found in milk which develops a rancid flavor. E.F.G.

437. Plant Processing and Control Methods in Preventing Oxidized Flavor. W. H. MARTIN, Kansas State College, Manhattan, Kansas. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 169, 1937.

Several treatments which have at times been suggested for preventing the flavor are mentioned. Factors on the production side which cause milk to be susceptible are listed. In the plant metallic contamination, cleaning and sterilizing and the effect of light at all points in processing and delivery is stressed. Discarding the first milk through the equipment is recommended.

E.F.G.

438. Variations in Susceptibility of Milk as Secreted by the Cow. E. O. ANDERSON, Connecticut State College, Storrs, Connecticut. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 153, 1937.

It is known that winter milk is higher in acidity and also more readily develops oxidized flavor than summer milk. Results on seven trials of .19% acidity milk compared with 7 trials of this milk reduced in acidity to .15% with $Na_2CO_35H_2O$ gave strong oxidized flavor in 4 of the former and only 2 of the latter samples at the end of 72 hours. Milk from different sources seems to vary in the reduction of acidity needed to inhibit oxidized flavor. The theory is advanced that the change in pH upon reduction in acidity has an effect upon enzymes secreted by the cow; that the cause and prevention of oxidized flavor is intimately associated with the nutrition of the animal.

E.F.G.

439. Off Flavors in Raw and Pasteurized Milk. G. M. TROUT, Michigan State College, East Lansing, Michigan. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 131, 1937.

The flavors of 920 cans of raw milk on a hot August day are reported as follows:

Flavor	No. of cans	% distribution
Clean and pleasant	413	44.89
Feed	219	23.80
Musty	101	10.97
High acid	73	7.93
Unclean	58	6.30
Barny	13	1.41
Cowy	12	1.30
Oily	13	1.41
Miscellaneous	18	1.95
Total	920	99.96

Flavors in the pasteurized milk of 22 dealers during September and October are given as follows:

Flavor	Percentage distribution Fresh 1 day	After 3 days
Clean, pleasant	13.3	12.0
Cooked or heated	65.5	30.9
Oxidized	5.5	20.7
Barny	4.4	.....
Cowy	3.3	.....
Metallic	1.1	5.2
Unclean	1.1	9.6
High acid	1.1	.....
Stale	.....	10.3
Flat	.....	10.3
Sour	.....	1.7
Total	99.7	99.7

Some flavors in raw bottled milk, homogenized and irradiated milk are mentioned. E.F.G.

439a. Theoretical Aspects of the Cause of Oxidized Flavor Particularly from the Lecithin Angle. L. M. THURSTON, Univ. of Florida, Gainesville, Florida. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 143, 1937.

The author suggests the following classification of milks from the standpoint of oxidized flavor:

1. Spontaneous milk: Milk which is capable of developing oxidized flavor spontaneously, *i.e.*, without the presence of iron or copper as a contaminant.

2. Susceptible milk: Milk which does not develop oxidized flavor spontaneously, but is susceptible in that contamination with copper or iron will cause development of the flavor.

3. Non-susceptible milk: Milk in which oxidized flavor cannot be produced by the addition of copper or iron.

The theory of an oxidizing enzyme in "spontaneous milk" of the catalytic effect of Fe and Cu in susceptible milk and the presence of increasing proportions of reducing substances in non-susceptible milk is discussed. Vitamin C is important in the latter instance.

Attention is called to the results obtained by various investigators to indicate the possibility of lecithin being the material oxidized in the case of "susceptible" milk, whereas in spontaneous milk it is both butterfat and lecithin-cephalin. The most likely present theory to explain the non-appearance of oxidized flavor in homogenized milk is the increased adsorption of protective protein on the surface of the fat globule.

Some reduction of the development of the flavor in milk agitated or frozen may possibly be explained by a reduced fat surface. "Spontaneous" milk heated to 165 to 168° F. probably results in destruction of the enzyme. Sun-

light alone is an oxidizing agent and the flavor produced differs from the so-called oxidized flavor found in "spontaneous milk" or caused by copper in susceptible milk. E.F.G.

440. The Resazurin Test for Sanitary Condition of Milk. G. A. Ramsdell, Bureau of Dairy Industry, U. S. D. A., Washington, D. C. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 3, 1937.

The resazurin test is found to be more rapid than the methylene blue test, and to be more sensitive to the reducing influences of pathological milks and physiologically abnormal milks. With the short incubation period of one hour the flora approximates more closely the initial flora than when longer incubation periods are used. The rate of change of color from blue to pink over several hours of incubation gives considerable information relative to the types of flora existing in the milk. E.F.G.

441. The Practical Value of the Phosphatase Test in Determining the Efficiency of Pasteurization. F. W. Gilcreas and W. S. Davis, New York State Dept. of Health, Albany, N. Y. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 34, 1937.

The details of the procedure and reagents used for the phosphatase test are described. Variation in incubation time from 24 hours to 18 hours had no significant effect upon the accuracy of the results. Reagents prepared commercially and buffer substrate tablets were found satisfactory. The phenol concentrations corresponding to various degrees of treatment have been established. Variations of 5 minutes or greater in heating time were readily distinguished and the addition of .1% or more of raw milk gave results indicating incomplete pasteurization. Variations in temperature were also easily detected. High temperature process pasteurization could also be checked. Application of the technique to 780 samples collected from delivery trucks and labeled pasteurized, detected the treatment of the milk correctly in 96% of the samples. E.F.G.

442. Determining the Efficiency of Milk Pasteurization. P. H. Tracy and A. J. Hahn, University of Illinois, Urbana, Illinois. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 57, 1937.

After a fairly comprehensive review of the literature with reference to the phosphatase test including an explanation of the principles involved the author suggests several aspects of the test which require further study. The Scharer modification of the phosphatase test devised by Kay and Graham is described in detail and was used in the work reported in securing the following results. The authors report attempts to improve Scharer's method by the application of the photoelectric cell in determining the degree of the

phenol color formed, thus making it possible to make more accurate determinations of the amount of phenol present. The principle and construction of the photoelectric cell is given in detail. The photoelectric cell made possible the detection of as low as .1% raw milk. Differences in holding time were more difficult to detect at 145° F. than at 142° F. In either case a raw sample which could be pasteurized under controlled conditions is needed as a reference sample. Corrosive sublimate tablets were found to be usable for preserving milk to be examined by the phosphatase test. E.F.G.

443. Dairymen Must Keep Milk Cold. L. H. BURGWALD, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bull. No. XXIII–4, March 31, 1938.

Examinations of the milk sent into Columbus by 10 dairymen showed that during February and March there was a progressive increase in the temperature of the milk and in the bacterial count. This experience points to the necessity for careful cooling at all seasons of the year. W.E.K.

444. Milk Trucking Interests Grow. C. G. MCBRIDE, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bull. No. XXIII–5, Apr. 7, 1938.

Because the trucking operation represents approximately 10 per cent of all the costs of marketing fluid milk, more economic control of this process is indicated. W.E.K.

445. Make Survey of Family Milk Use. HUGHINA MCKAY, Ohio Agr. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bull. No. XXIII–8, Apr. 28, 1938.

A survey of 28,966 families in 59 cities revealed that the average weekly consumption of milk was 2.44 quarts; that less than 1 quart per person weekly was purchased by 4,126 families; that 529 of these families bought no milk W.E.K.

446. A Study of Causes of Damage to Cap, Seat and Bead of Comalac Universal Milk Bottles. MARCUS DEY, Golden State Co., Ltd., Los Angeles, California. Ann. Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 21, 1937.

This comprehensive study was undertaken at the direction of Comalac, reported to be the largest purchaser of milk bottles in this country, to discover the causes of so much chippage on the tip and bead of Comalac bottles. Some of the results are:

1. 2.9 per cent of new quarts received from the factory were defective.
2. Differences in chipping were observed in ware from different plants. "Over pressed" cap seats were a contributing factor.

3. Two wire cases are a definite cause of bead chippage and their use should be discontinued.

4. Bottle washing operations cause extreme damage to bead and cap seat. Comparisons of washers are given and suggestions for operation to reduce injury to bottles.

5. Corrosive bottle washing materials cause spalled glass and is the forerunner of etching and chipping. The solubility of glass in various washing materials is given. The least solubility, .878 per cent, was obtained with a mixture of flake caustic 50 per cent and sodium metasilicate 50 per cent.

6. Capping machines do not damage the cap seat.

7. Significant damage to the bead or finish resulted when filled bottles were cased 4 at a time but not when cased 2 at a time.

8. Only 1.6 per cent of bottles were damaged on the bead when in the hands of retail customers.

9. Investigation of handling and transporting of cased bottles deserves to reduce damage. Specific recommendations are given. E.F.G.

447. How Milk is Produced and Distributed in the Argentine. W. Bob S. Fels, Sales Mgr. of the farm-ranch, "Estancia Tatay," Buenos Aires, Argentine. Milk Dealer *27*, 5, p. 40, Feb. 1938.

A description of the milk industry in the Argentine, especially as carried on by the farm-ranch Estancia Tatay. This farm-ranch has approximately 15,000 head of cattle and the milk is pasteurized on the farm where it is produced. C.J.B.

448. Preventing the Oxidized Flavor in Milk and Milk Products. C. D. Dahle, Dairy Dept., Penn. State College, State College, Pa. Milk Dealer *27*, 5, p. 68, Feb. 1938.

A report of experimental work with oxidized flavor in milk. The author draws the following conclusions: 1. There are numerous means for delaying or preventing the onset of flavors in dairy products that are of an oxidative nature. 2. In milk, in which the flavor develops spontaneously, high temperature (170° F.), homogenization, nitrogen replacement of the free oxygen, increasing bacterial population, feed and anti-oxidants are effective. 3. Certain anti-oxidants in other fats are pro-oxidants in milk fat. 4. An anti-oxidant contained in oat flour proved to be particularly efficient. C.J.B.

449. The Phosphatase Test for Determining Efficiency of Pasteurization. E. H. Parfitt. Milk Plant Mo. *27*, 1, p. 34, Jan. 1938.

The author gives a comprehensive summary of the phosphatase test, the principles involved, the methods used, applications and precautions. G.M.T.

450. The Use of Chlorine Disinfectant in the Sterilization of Dairy Equipment. Lewis Shere. Milk Plant Mo. *27*, 1, p. 42, Jan. 1938.

Methods of sterilizing dairy equipment are given with special reference to the selection and use of chlorine, pointing out the differences in the corrosive action of chlorine sterilizers. G.M.T.

451. Now is the Time and Here is the Way to Tackle the Fly and Insect Problem. E. M. Searls, Fred M. Snyder, and C. L. Fluke. Milk Plant Mo. *27*, 4, p. 32, April 1938.

Precautions to observe in the selection and use of sprays are given as well as types of sprayers to use and methods for testing them. Life cycles of some insects are presented. A number of control measures are discussed. G.M.T.

452. Daylight Versus Night Delivery. F. E. Rogers. Milk Plant Mo. *27*, 3, p. 28, March 1938.

A discussion of the possible changes in systems of milk delivery giving the advantages and disadvantages of the daylight delivery system. G.M.T.

453. What Makes Milk Stone, How to Prevent It and How to Eliminate It. H. A. Ruehe. Milk Plant Mo. *27*, 4, p. 30, April 1938.

The composition of milk stone is dependent somewhat upon the product, ice cream mix, cream, skim milk, or whole milk, from which it is precipitated. Generally formed by the precipitation of calcium, sodium, and magnesium phosphate by heat, it contains also some entrapped fat. Analysis of milk stone from a vat coil used for pasteurizing ice cream mix at 160° F. showed the milk stone to contain 43.54 per cent protein, 42.03 per cent ash and 12.44 per cent ether extract (fat); whereas holder pasteurized whole milk stone contained 31.19 per cent protein, 5.62 per cent ash and 42.65 per cent ether extract; and 180° F. skim milk stone had 37.82 per cent protein, 52.6 per cent ash and 6.08 per cent ether extract. Prevention of milk stone formation may be accomplished (1) by proper adjustment of the heating medium during pasteurization (2) by use of non-film-forming washing compounds with hard water and (3) by rinsing with cold water rather than hot when the water is hard. Equipment may be freed from milk stone deposits by use of $\frac{1}{10}$ of 1 per cent tartaric acid or by use of commercial compounds especially prepared for that purpose. G.M.T.

454. The Action of Sunlight on Milk. Lascar Buruiana, Dept. of Vet. Med., Univ. of Bucharest. Biochem. J. *31:* 1452, 1937.

The influence of various factors responsible for the reduction of methylene blue in milk exposed to sunlight has been reviewed experimentally, and certain phenomena distinguished.

Two effects are noted:

(1) Oxidation of unsaturated fat. This phenomenon is independent of the decoloration of methylene blue. The reduction of methylene blue is, however, aided by this oxidation of the unsaturated fat, which produces anaerobic conditions in the milk by using up the dissolved oxygen and thus allows the second phenomenon to appear.

(2) Oxidation by catalytic dehydrogenation of the ascorbic acid present in the milk. This dehydrogenation is responsible for the decoloration of the methylene blue, which serves as hydrogen acceptor. When all the ascorbic acid has been oxidized, the color of the methylene blue is restored if air or oxygen be admitted. The determination of the substances oxidizable by iodine before and after exposure to sunlight can be used to evaluate the vitamin C content of milk. The results of this method agree well with those obtained by direct titration with 2:6-dichlorphenolindophenol by the Schlemmer method. The rate of reduction of methylene blue on exposure of milk to sunlight does not give quantitative information of the content of ascorbic acid because this rate depends on the amount of unsaturated fat present, which plays a part described above as oxygen absorption. With the exception of mare's milk, the milks examined did not contain reduced glutathione. K.G.W.

455. Irradiation of Milk. Factors Affecting Antirachitic Response. H. H. Beck, H. C. Jackson and K. G. Weckel, Univ. of Wisconsin, Madison, Wis. Ind. & Eng. Chem. *30:* 632–639, 1938.

A study was made of factors affecting the efficiency of commercial irradiating equipment in the photochemical synthesis of vitamin D in fluid and evaporated milk exposed in flowing films. A high-pressure, air-cooled quartz mercury-vapor arc provided the radiation, the intensity of which was measured, recorded and maintained automatically. The rate of flow of the milk and the width of film on a vertical, stainless steel surface was controlled while the elevation and distance of the arc from the milk film was adjustable. The variations in radiant energy impinging on the film depend on the solid angle of radiation intercepted by the surface. This is conceived as a rectangular pyramid with apex at the center of the arc and base delineated by the limits of the rectangular surface. To determine the most suitable solid angle, the film travel distance, length of vertical angle, and film width of horizontal angle, were independently varied. The effectiveness of the irradiation was measured by bioassay methods.

Distances of the arc of 4, 6, 8 and 10 inches from the center of the film were used with emission rates producing intensities in wave lengths of less than 3000 A° of 1000, 2000, 4000 and 6000 microwatts measured at a distance of 8 inches horizontally opposite the center of the arc. The plan permitted the variation of radiation intensity while applying a constant amount of energy within the fixed solid angle of radiation. Experiments

were conducted with four rates of milk flow with each of four rates of energy emission at each of four distances from the arc. Both fresh milk and homogenized evaporated milk were studied.

The effect of varying the horizontal and vertical angles was found to be an increase of vitamin D potency with an increase in vertical angle of radiation up to 100° and a decrease in potency as the horizontal angle is widened beyond 60°. Hence, the effective solid angle of radiation for these experiments was defined as one having 90° vertical and horizontal angles. Limiting the applied radiations in this manner, 6 inches proved to be the optimum distance between arc and film for maximum potency, independent of intensity and film capacity. It is assumed that other little-known factors are involved in determining the effectiveness of this 6 inch distance.

The vitamin D potency bears a parabolic relationship to the amount of radiant energy applied. Analyses of the data reveal that, for any given distance between arc and film, identical variations in the amount of applied energy, however produced, have identical effects measured in terms of vitamin D potency of the milk. This holds true even for successive exposures of the milk. This leads to the generalization that irradiation of flowing films of milk with a given radiation source at a given distance from the film produces an antirachitic potency dependent upon the number of successive exposures, the film capacity, and the radiation intensity, only insofar as these affect the amount of applied energy.

From their data the authors derive a mathematical expression for the potency-energy relations as follows:

$$P = KA^{1/n}\frac{I^{1/n}}{Q^{1/n}} \text{ where}$$

I = intensity
A = area of milk film
Q = quantity discharge per unit time
K = a constant
1/n = decimal exponent in equivalent fraction, ranging between 0.5 and 0.6

Allowing for maximum deviations of 10 per cent in I and Q, the variations in potency of the milk will lie within the limits of accuracy of the bioassay method.

Since the film capacity-potency relation is hyperbolic and the intensity-potency relation is parabolic, it is desirable to employ sufficiently high intensities and film capacities to avoid excessive variations in potencies. Present commercial equipment satisfies the limitations developed by these investigators. J.H.N.

Other abstracts of interest are numbers 372, 374, 375, 376, 379, 393, 394, 395, 396, 397, 398, 399, 401, 403, 459, 463 and 464.

MISCELLANEOUS

456. Cold Storage Locker Plants. MARVIN A. SCHAARS. Univ. of Wisconsin, Madison, Wis. Nat. Butter and Cheese Jr. Article I, *29*, 11, p. 6, June 10th, 1938; Article II, *29*, 12, p. 6, June 25, 1938.

Article I. About 90 per cent of approximately 2,000 cold storage locker plants have been built since 1936. They are operating in northern and western states chiefly, but are reported in at least twenty-one states. Some provide cold storage space only; others furnish a butchering service which includes butchering, chilling, cutting, wrapping, grinding, smoking, curing, and the like. The modern plant provides rooms for chilling, ageing, cutting, sharp freezing and lockers. Investment in refrigerating machines, insulation, lockers and equipment fully installed, and for land and building total approximately $25.00 to $35.00 per locker in plants with 200 to 500 lockers. Limited information on cost of operation makes it possible to estimate an approximate cost per year of $11.46 and $10.62 per locker in complete service plants of 300 and 500 locker capacities, respectively. This cost is exclusive of interest on investment. Earning capacities of locker plants are discussed and estimates are shown that suggest a net return on the investment approximately 10 per cent.

Article II. Locker plants may be licensed by the state in which they operate. Plants may be operated in conjunction with some other enterprise, such as cheese factories, creameries, ice plants, meat markets and grocery stores. Locker plants may be either privately or cooperatively owned and operated. An ideal location is a thriving small town up to 5,000 population which is surrounded by a thickly populated farming area. Successfully operated city plants indicate that operations are not restricted to rural communities. Existing plants draw 75 to 85 per cent of their patronage from farmers. The permanency of the locker system can be assured if it provides an economical, attractive service that fits in with the modern household economy. W.V.P.

457. A Trial with Tempoary Silos. W. E. KRAUSS, C. C. HAYDEN, A. E. PERKINS and R. G. WASHBURN. Ohio Agric. Exper. Sta., Wooster, Ohio. Ohio Bimonthly Bull. Vol. XXIII, No. 192, May–June, 1938.

Second cutting alfalfa was put up in temporary silos of the snow fence type. The material in one silo was untreated; molasses at the rate of 2 per cent was added to that of a second; and the A. I. V. treatment was applied to the alfalfa put into a third silo. Much spoilage occurred in all three silos, particularly at the top and around the edges. Carotene preservation was best in the molasses-treated material. In a palatability trial cows preferred corn silage to alfalfa silage. The carotene content of the milk pro-

duced varied in accordance with the carotene content of the silage. Suggestions and precautions concerning the use of temporary silos are given, chief of which is that temporary silos are probably best adapted to storing a late crop for feeding in the fall or early winter to supplement and extend the use of a permanent silo. W.E.K.

458. Protein Production Increased by Liming. E. E. BARNES, Ohio Agric. Exper. Sta., Wooster, Ohio. Ohio Exper. Sta. Weekly Press Bull. No. XXIII–18, July 7, 1938.

A 3-year rotation of corn, small grain, and hay (red clover, mammoth clover, alsike clover, sweet clover, alfalfa, soybeans, or timothy) was followed on soil limed to the neutral point and on unlimed soil with a pH of 5.0. On an average, liming to the neutral point increased the yield of dry matter 77 per cent and the protein 112 per cent. W.E.K.

459. A. I. V. Silage. H. T. GREENE and H. OTTERSON, Brook Hill Farm, Genesee Depot, Wis. Cert. Milk *13*, 144, p. 9, April 1938.

This paper deals largely with a review of recent investigations as to values found in A.I.V. silage. The following subjects are discussed in connection with A.I.V. silage: Grass juice factor, use of different acids in the manufacture of carotenoids, and proteins and nitrogen compounds. W.S.M.

460. Eleventh World's Dairy Congress. A. C. DAHLBERG, New York Exp. Sta., Geneva, New York. Ann. Conv. Intern. Assoc. Milk Dealers, Laboratory Section, P. 79. 1937.

The author reports an attendance of 3,760 from 53 countries of which slightly less than half were from Germany, the congress meeting in Berlin. Seventy-two registered from U. S. A brief digest is given of many of the noteworthy papers, particularly those which dealt with milk from the standpoint of sanitation, disease control, composition and flavor, quality control, nutritive value and methods of processing. It was noted that the reports dealt largely with problems under European conditions. E.F.G.

461. Cooperative Experiments in Pasture Improvement. D. R. DODD, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Bimonthly Bull. 23, No. 191: p. 39, 1938.

This is a progress report of results obtained from 1931 through 1937 in experiments with fertilizers on pasture situated at many points throughout Ohio. Best yields of both total and desirable herbage were obtained when combinations of superphosphate and sulfate of ammonia, or superphosphate, muriate of potash, or sulfate of ammonia were used. Equivalent production and returns also favored these treatments.

The relative amount of white clover in the pasture was found to influence

herbage yield and possible returns. Phosphate alone lowers the cost and greatly increases the returns where a high clover content can be maintained. Nitrogen in addition has little effect on returns and greatly increases the cost. when clover can not be grown the addition of nitrogen is effective.

These tests are cited as evidence to justify the general improvement of adapted permanent pasture lands. W.E.K.

462. Management Factor in Pasture Improvement. D. R. DODD, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bull. XXIII 4, March 31, 1938.

Experiments in which different heights and frequency of clipping were practiced showed that short, frequent clipping affected adversely the yield and character of the herbage. Controlled grazing, mowing, or both, are suggested for keeping the growth of herbage under control. W.E.K.

463. Can Make Good Silage of Certain Hay Crops. Dairy Dept., Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bull. No. XXIII–8, Apr. 28, 1938.

Good silage can be made from such hay crops as alfalfa, clover, and soybeans, or mixtures of these with grasses or corn. The use of molasses for legumes is recommended. W.E.K.

464. Industry's Responsibility in Labor Relations. C. A. JAY, Dallas Open Shop Association. Ann. Conv. Intern. Assoc. Milk Dealers, General Sessions, p. 83, 1937.

The effects of the National Labor Relations Act in prevention of strikes which is stated as one of its objects, can be judged by the fact that in the four years, 1933–1936 inclusive, the number of workers involved in strikes was 299 per cent greater than in the four years, 1929–1933 inclusive, and the number of man-days lost was 152.5 per cent greater in the latter period. Ignorance of the National Labor Relations Act and disregard of its provisions has resulted in confusion. Every employer should know what the act requires and what it does not. The writer proceeds to explain many of the more important provisions of the Act as they specify employer-employee relations and what each can and cannot do. No single piece of legislation heretofore proposed, has had such far-reaching potential consequences as that to fix wages and hours of labor in American industry.

The author states that he believes such a law is undesirable because it is impossible of accomplishment. He then outlines the basis of such a law if it is granted that it is inevitable. He recommends first that labor problems be a major subject for study by the Association and second, that a better understanding between employer and employee be developed. The milk industry cannot indiscriminately increase the cost of its product in order to

meet wage scales which are out of line with the earnings of the average customer of this industry. E.F.G.

465. Getting Maximum Results from the Refrigerating System. H. A. RUEHE, Dept. of Dairy Husbandry, Univ. of Ill., Urbana, Ill. Ice Cream Rev. *21*, 10, p. 104, May 1938.

Some of the factors which affect efficiency in refrigerating machinery and which any operator can remedy are given. J.H.E.

466. Storage Lockers for Revenue. ANONYMOUS. Ice Cream Field *32*, 5, p. 20, April 1938.

It is pointed out that many cold storage plants now provide rented lockers in which tradesmen and others may store perishables.

The opportunity of supplying this service in smaller towns is open to many ice cream manufacturers, milk dealers, creamery men and cheese factory operators equipped with cold storage facilities. W.C.C.

PHYSIOLOGY

467. The Effect of Sympathectomy on Gestation and Lactation in the Cat. F. A. SIMEONE and J. F. ROSS, Department of Physiology in the Harvard Medical School. Am. J. Physiol. *122:* 3, 659, 1938.

Observations are reported on gestation, parturition and lactation in totally and partially sympathectomized cats shortly after completion of the surgical procedures and a year later. The incidence of abortions is high in animals that become pregnant shortly after sympathetic denervation of the internal genitalia. The incidence of stillbirths is high in animals that become pregnant long after sympathectomy. Sympathetic denervation of the mammary glands caused definite variation from normal functioning activity, recognizable histologically, in only 1 out of 7 pregnancies that went to term. D.L.E.

468. The Effect of Thyroxin on the Carbohydrate Metabolism of Hypophysectomized Rats. JANE A. RUSSELL, Institute of Experimental Biology, Univ. of California, Berkeley. Am. J. Physiol., *122:* 3, 547, 1938.

Thyroxin substitution therapy in hypophysectomized rats can restore the rate of absorption of glucose from the intestine completely to normal. The dose of crystalline thyroxin necessary for this action is less than that required to restore the metabolic rate. This treatment does not improve the maintenance of carbohydrate stores during the fasting or change the proportionate disposition of absorbed glucose in hypophysectomized rats. D.L.E.

469. Pancreatectomy in the Goat. F. D. W. Lukins and George S. Cox, Medical Research Institute, Univ. of Pennsylvania, Philadelphia. Am. J. Physiol. *122:* 729, 1938.

Four young goats were depancreatized. Following pancreatectomy, the goat has a mild type of diabetes as measured by the extremely low glycosuria and low, although increased, nitrogen excretion. Unlike the cat, dog and pig, ketonuria is slight or absent.

Explanations are offered to explain why depancreatized goats manifest a certain ability to utilize carbohydrate, as shown by two animals in which glucose was given intravenously, and only 25 to 50 per cent excreted. Even when the sugar was given by stomach tube, no sugar could be aspirated a few hours later. The assumption is made that glucose is fermented or otherwise transformed in the herbivorous stomach and absorbed in some non-reducing form. D.L.E.

470. Factors Determining Voluntary Ingestion of Water in Normals and in Individuals with Maximum Diabetes Insipidus. Curt P. Richter, Psychobiological Laboratory, and Henry Phipps Psychiatric Clinic, Johns Hopkins Hospital, Baltimore, Md. Am. J. Physiol, *122:* 668, 1938.

The voluntary water intake of normal animals and humans was found to be a function of surface area rather than of body weight, and hence must be a function of metabolism. The average daily intake per square meter body surface varied from 1,050 cc. to 1,238 cc. in rats, cats, dogs, monkeys, and humans, averaging 1,142 cc.

The maximum voluntary water intake in animals with diabetes insipidus was found to be a function of body weight rather than of body surface. The regulatory action of the posterior lobe secretion on the maintenance of the water balance is described. It was suggested that the level of the maximum intake with diabetes insipidus might be determined by the maximum capacity of the kidney or by the maximum capacity of all the cellular spaces of the body, both of which would be functions of body weight. D.L.E.

471. The Effects of Inanition on Temperature Regulation. George Clark, Institute of Neurology, Northwestern Univ. Medical School. Am. J. Physiol., *122:* 646, 1938.

Normal well-nourished cats when placed on an inadequate diet react normally to cold until the weight loss considerably exceeds 30 per cent. The rectal temperature of cats, which have lost considerably more than 30 per cent of their original weight as a result of an inadequate diet, drops to extremely low levels upon exposure to cold.

The responses to heat are not interfered with by weight losses which cause abnormal responses to cold. D.L.E.

472. A Simple Apparatus for Milking Small Laboratory Animals. P. L. TEMPLE and J. K. KON, National Institute for Research in Dairying, Univ. of Reading. Biochem. J. *31:* 2197, 1937.

A diagrammatic discussion of the instrument is presented. K.G.W.

473. The Utilization of Lactic Acid by the Lactating Mammary Gland. W. R. GRAHAM, JR. Dept. of Dairy Husbandry, Univ. of Mo., Columbia, Mo. J. Biol. Chem. *122*: 1, 1937.

The experiments show that considerably more lactose was being secreted than could be accounted for by the removal of glucose from the blood and that other carbohydrate-forming compounds must be taken up by the gland. Glucose, lactic acid, and amino nitrogen are removed from the blood in substantial amounts. Eighty-five per cent of the lactose formed during the experimental period could be accounted for theoretically from glucose and lactic acid from the blood, the remaining 15 per cent may be accounted for if the amino nitrogen removed from the blood is calculated as a 3-carbon amino acid, which may be converted into lactic acid. Because experiments indicate lactic acid is produced rather than absorbed by the gland, this acid may be an important precursor of lactose of milk. K.G.W.

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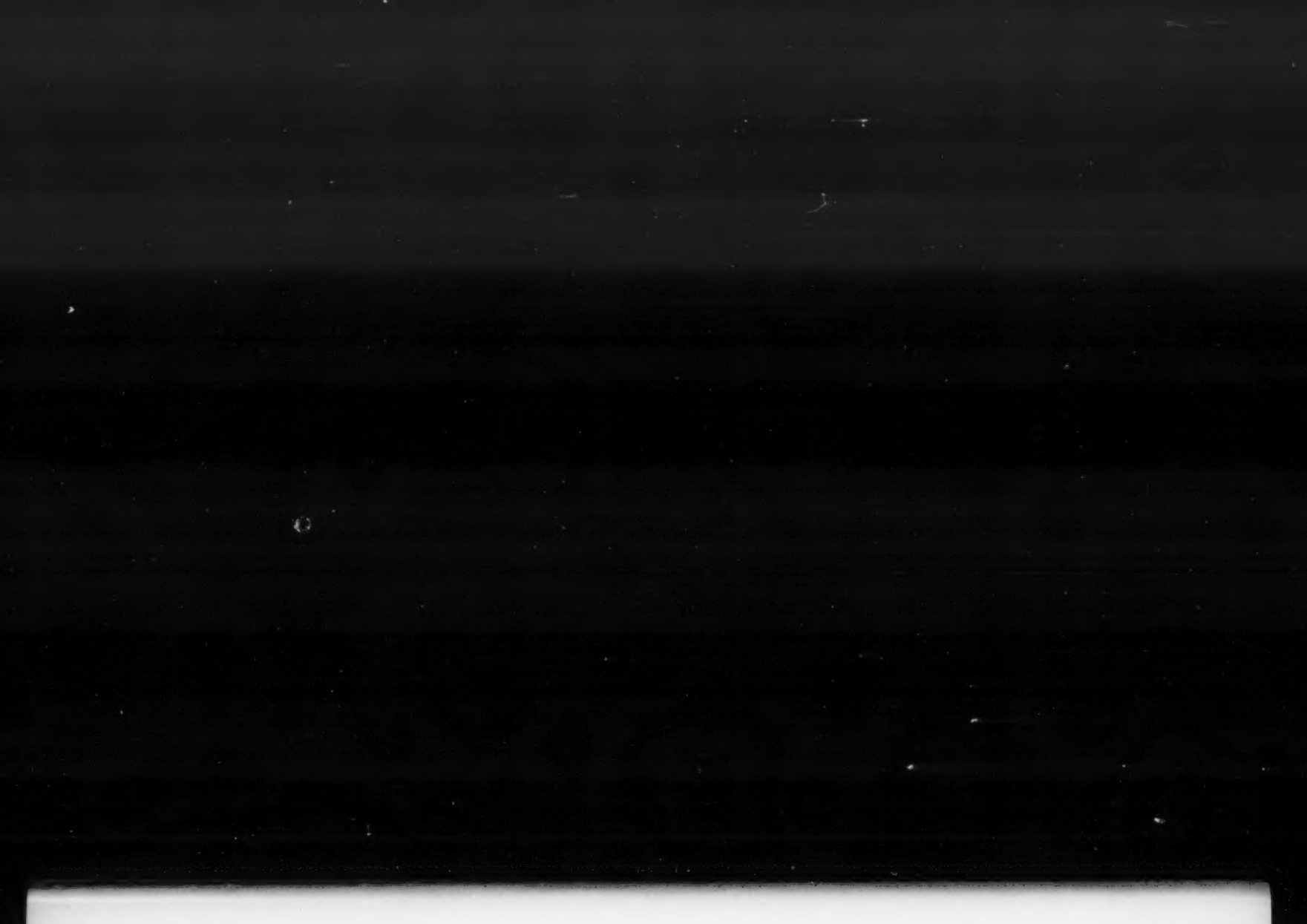

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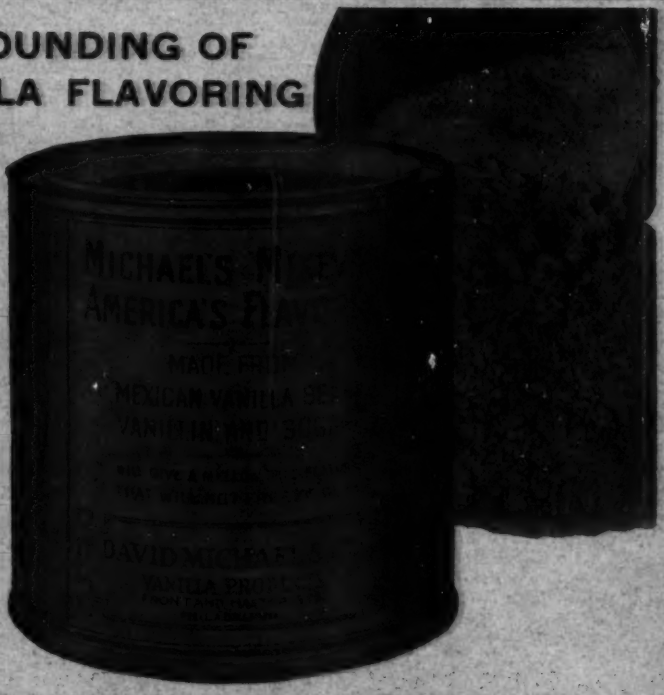

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